U.S Steel Minntac

Twin Lakes Wild Rice Restoration

Opportunities Plan

2016 Annual Report

December 30, 2016

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Prepared For

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EXECUTIVE SUMMARY

The third full year of work related to the Twin Lakes Wild Rice Restoration Opportunities Plan (Plan) was completed during 2016. The Plan was developed and undertaken to satisfy Special Condition 10 of the United States Army Corps of Engineers Wetland Permit 2011-00823-JCB.

Plan activities were initiated prior to freeze-up in 2013. The first full year of Plan activities to begin the process of assessing the potential for restoring healthy stands of wild rice in the Twin Lakes was completed in 2014. A majority of these activities were continued during 2015. At the end of 2015, wild rice was planted in six separate plots, three each on both Little Sandy and Sandy Lakes. After finding five out of the six plots growing wild rice in late June of 2016, a majority of the work effort was focused on the wild rice plots, as well as water and sediment pore water quality in these areas. Although minimal beaver activity was observed during 2016, above average rainfall, beginning in May and continuing through September, resulted in high lake levels throughout the growing season. Current physical conditions, such as water depth increases and fluctuations, within the Twin Lakes system may not be conducive to wild rice growth and development throughout the majority of the Twin Lakes system. Peepers were once again used to measure sediment pore water quality in various portions of the Twin Lakes system. Overall, the pore water in the Twin Lakes sediment showed low hydrogen sulfide and high iron concentrations; however, the sediment pore water on the west end of Little Sandy Lake (specifically the Inflow 2 location) was found to have very high sulfide and corresponding low iron levels. These topics, along with the regular water quality and quantity characterizations, are discussed in more detail in their specific sections of this report. Work on the Plan will continue through 2017, as required by permit.

1.0 INTRODUCTION

On December 10, 2012, the United States Army Corps of Engineers (Corps) issued Wetland Permit 2011-00823-JCB for wetland impacts resulting from the United States Steel (U. S. Steel) Minntac Western Progression Project. Special Condition 9 of Wetland Permit 2011-00823-JCB required U. S. Steel to submit a Twin Lakes Wild Rice Restoration Opportunities Plan (Plan) within 120 days of permit issuance. U. S. Steel submitted the Plan in final form (Revision 1) to the Corps on August 6, 2013. Special Condition 10 of the permit required implementation of the Plan no later than October 31, 2013. Activities related to the Plan were initiated on October 9, 2013. On November 22, 2013, the Corps approved Revision 1 of the Plan. Plan activities completed during 2014 and 2015 are provided in annual reports submitted to the Corps for each of those two years.

During 2016, a number of activities were completed in support of the Plan and / or in preparation for initiation, continuation, and / or completion of components of the Plan during subsequent monitoring seasons. The following provides the details of Plan activities undertaken during 2016, in partial fulfillment of Special Condition 10 contained in Corps Wetland Permit 2011-00823-JCB, and represents the culmination of three full years of work related to the required five-year work plan. It should be noted that, at this time, it is premature to draw any definitive conclusions with respect to any specific wild rice restoration opportunities for the Twin Lakes. However, discussion of preliminary results will be included in individual sections as appropriate.

2.0 WORK COMPLETED IN 2016

2.1 TWIN LAKES RAINFALL, WATER DEPTH, AND TEMPERATURE MONITORING

To evaluate the effect of natural hydrologic inputs to and outputs from the Twin Lakes system, and implementation of various aspects of the Plan, the depth of water at the northwest side of the steel bridge which separates the two lakes has been monitored. To facilitate continuous water level measurements, an OTT / Hach pressure transducer (PT) was purchased and deployed for approximately 1.5 months in 2013, 6 full months in 2014 and 6.5 months in 2015. On April 21, 2016, immediately following ice-out, the PT was re-deployed at the same location and continued operating until removal on November 17, 2016. Typically, the PT had data downloaded once a month during the water sampling/monitoring event. The PT performed well with no lost data during the 2016 deployment. Daily precipitation totals were collected at the USS Minntac Tailings Basin weather information collection site approximately two miles southwest of the PT location and was compiled for comparative purposes. The results of the 2016 monitoring for rainfall, water depth, and temperature can be found in Appendix A.

The graph in Appendix A does indicate that the Twin Lakes water depth is greatly affected by rainfall. The local weather service has stated that 2016 was one of the wettest summers on record and even with the elimination of the beaver along Sand River, the water remained elevated for most of the summer. There was one period, in late May 2016, where the water dropped below 2.5'. The rest of the period never saw that level again until mid-November. Further discussion concerning the water level will be made in Section 2.6 Twin Lakes Inflow / Outflow Flow Measurements and Section 2.8 Sand River (and Twin Lakes) Beaver and Dam Removal Activities.

In an effort to better detail water depth fluctuations within the Twin Lakes system, six bathymetric maps of Little Sandy and Sandy Lakes (April – September 2016) were constructed using water depth measurements from the Twin Lakes bridge pressure transducer (Appendix A) and water depth measurements obtained during the 2016 aquatic plant survey. See Section 2.7 (Figure 5) for additional details.

2.2 Twin Lakes Sediment Bioassay

During October 2013, multiple sediment sampling events were completed to collect sediment samples from each lake for use in a wild rice bioassay. During 2013 and 2014, initial wild rice bioassays were completed using bulk sediment sampled from Sandy Lake. Initial results of the wild rice sediment bioassay support the conclusion that wild rice seed (obtained from Whitefish Lake, Ontario) successfully germinated and developed into viable seedlings during exposure to sediment sampled from Sandy Lake.

The 2016 wild rice bioassay using Twin Lakes sediment and surface water was scheduled to be completed during late summer or early fall (2016). This component of the Twin Lakes work plan was postponed due to the July 2016 observance of wild rice growth in areas that were planted with wild rice seed during Fall 2015. In general, previously completed wild rice bioassays during 2013 and 2014 correctly predicted how wild rice seed may respond when exposed to sediment from Sandy Lake. Additionally, wild rice seed germinated and grew into floating leaf and / or mature aerial stage plants in multiple locations on Little Sandy Lake.

During October 2015, wild rice seed was broadcast over six test plots within the Twin Lakes system; three plots in Little Sandy Lake and three plots in Sandy Lake. During August 2016, mature seed-producing wild rice plants were observed growing in four of the six test plots; all three plots in Sandy Lake and one test plot in Little Sandy Lake. Any future efforts towards bioassay development will focus on using sediment obtained from the two areas in Little Sandy Lake in which mature seed-producing wild rice plants were not observed.

2.3 Twin Lakes Sediment Peeper Pore Water

During October 2013, multiple sediment sampling events were completed to obtain a sufficient number of samples to characterize Little Sandy and Sandy Lake sediment conditions. Dr. Peter Lee has previously provided an evaluation of sediment pore water characteristics including a comparison between Little Sandy Lake and Sandy Lake, previous MPCA pore water data, and a Canadian wild rice producing lake (Whitefish Lake) (see Appendix B in 2015 Annual Report).

During the 2015 field season, a total of six peepers were deployed in the Twin Lakes; two in Sandy Lake and four in Little Sandy Lake. The reasons for the uneven distribution between the two lakes were efforts to measure pore water characteristics near inflows to the Twin Lakes system, measure any changes in sediment pore water as distance from inflows increased, and measure pore water characteristics at the outflow from the Twin Lakes system (Figure 1). The 'Little Sandy Lake Out,' and 'Sandy Lake Mid' peeper locations were chosen to measure sediment pore water characteristics in a location that also had a sufficient penetrable depth of sediment for secure peeper deployment. Three, one-month deployments of each of the six peepers were completed: July – August; August – September; and September – October 2015. Peepers were constructed to obtain representative sediment pore water samples from the top 10 cm of sediment; approximately 200 mL of sample were obtained from each peeper during each deployment.

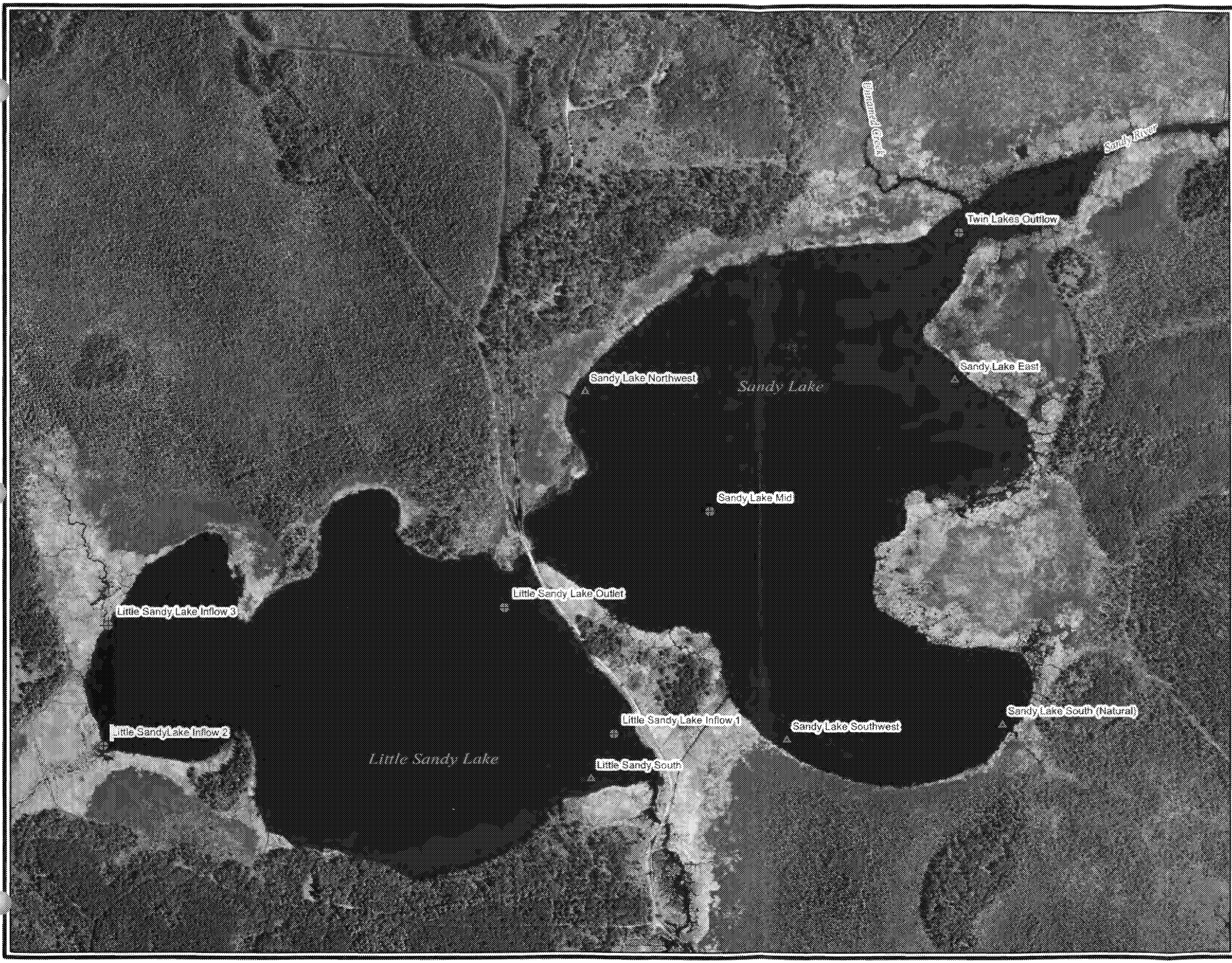
During the 2016 field season, six peepers were deployed in the Twin Lakes; two in Sandy Lake and four in Little Sandy Lake – in the same locations as during the 2015 field season (Figure 1). Peepers were deployed for four, one-month durations: April – May; May – June; June – July; and July – August 2016. In addition to these pore water samples, peepers were deployed for one-month durations in locations in each lake where wild rice was observed growing in test plots seeded in October 2015 (Figure 1). These above-and-beyond peeper deployments were completed to characterize sediment pore water within observed wild rice growth areas; with specific emphasis on hydrogen sulfide and extractable iron.

During 2016, the highest sediment pore water hydrogen sulfide concentrations were measured from samples obtained at the Inflow 2 monitoring location. Concurrently, the lowest extractable iron concentrations were measured in samples also obtained at this monitoring location. These data tend to indicate that as hydrogen sulfide is produced in the pore water, available iron is bound as iron sulfide; thus decreasing the pore water extractable iron available to bind with (hydrogen) sulfide. The increasing hydrogen sulfide concentrations throughout most of the summer suggest that hydrogen sulfide generation exceeded the available iron for iron sulfide formation at this monitoring location.

2.4 Twin Lakes Sediment 100 Year Pollen Count

Sediment core samples were obtained for completion of a '100 Year Pollen Count' on May 30, 2014. During 2015, sediment from the two cores selected for the 100 Year Pollen Count (LSL2 and SL1) was analyzed using scanning electron microscopy (SEM) observation. Pollen grains that were likely derived from wild rice were observed in the Sandy Lake sediment (see Figure 2). Details of this analysis were provided in the 2015 Annual Report.

Although these do appear to be wild rice pollen grains, currently a verification process is being completed. Pollen from known wild rice plants is being imaged to confirm that the pollen grains imaged from Sandy Lake sediment are wild rice pollen grains. During August 2016, pollen was sampled from wild rice plants growing in Sandy Lake, which were growing in plots as a part of a wild rice test seeding event completed during October 2015. Preparation and imaging of pollen samples obtained during August 2016 is currently in progress and are scheduled to be available for the 2017 Annual Report.



N

0 250 500 1,000

Feet

1 inch = 500 Feet

Legend

- Peeper Deployment
- Wild Rice Peeper Deployment

Figure 1
2016 Peeper Deployment Locations

Twin Lakes
US Steel Corporation -
Minnesota Ore Operations
Mt. Iron, Minnesota (St. Louis County)

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Drawn By : Evan Johnson
NTS Project #: 10170E

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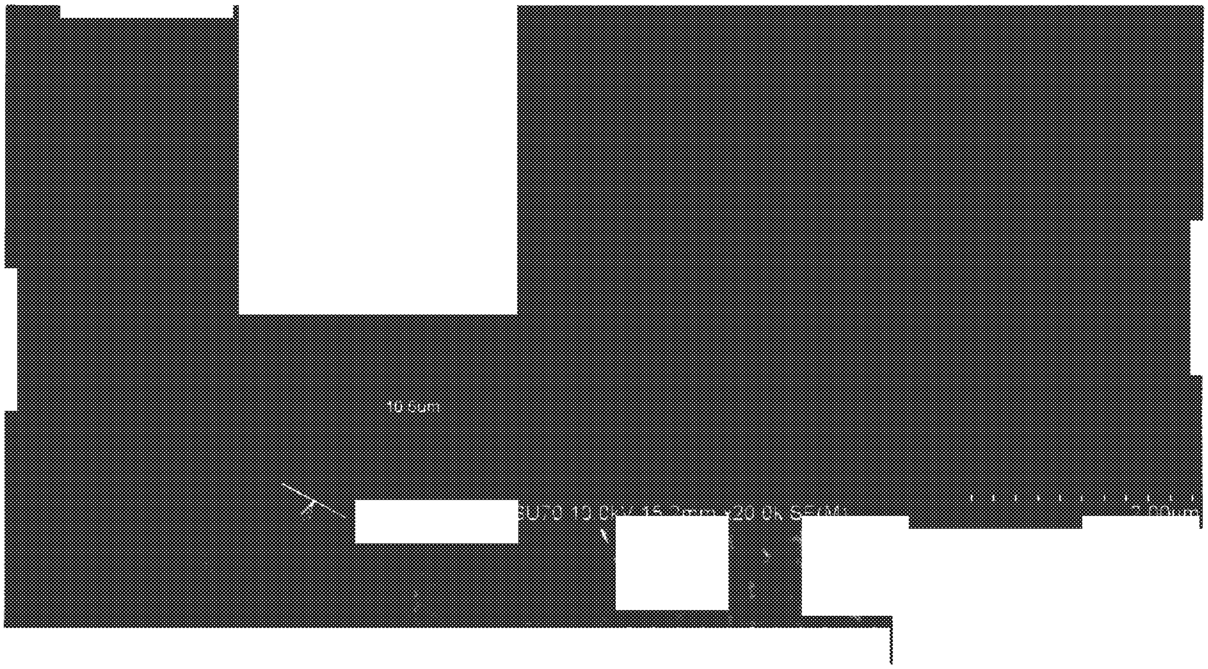
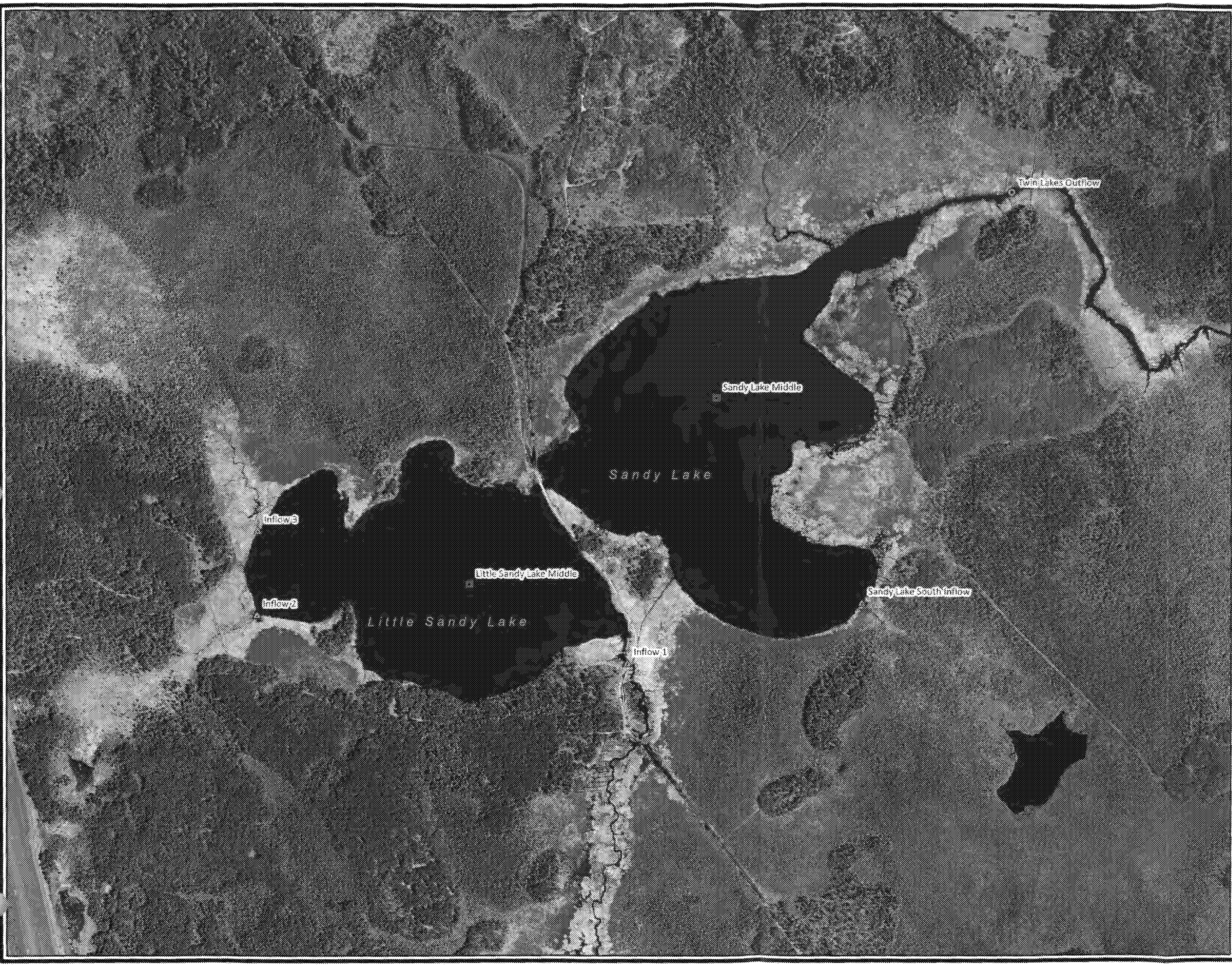


Figure 2. Scanning electron microscope (SEM) image of likely wild rice (WR) pollen grain obtained from a 2013 Sandy Lake sediment core sample. WR pollen grains were sampled in 2016 from WR plants growing in Sandy Lake test plots seeded in 2015. Additional images of sampled WR pollen will be used to aid in identifying the above pollen grain image.

2.5 TWIN [illegible]KES INFLOW / OUTFLOW WATER CHARACTERIZATION

Beginning May 26, 2016, monthly water quality sampling and flow monitoring of inflow and outflow from the Twin Lake system wa[illegible] sources (see Figure 3) include[illegible] lows to Little Sandy Lake, a tributary to Sandy Lake from the north into its northeast arm (Culve[illegible], anot[illegible]ributary to Sandy Lake from the south (Sandy Lake South Inflow), and the Twin [illegible]tem ou[illegible]in Lakes Outflow, previously referred to as Outflow 2 Sand River). It should be noted that the inflow samp[illegible] above were collected either from active, measurable inflow (Inflow 1, the Culvert Inflow and the Sandy Lake South Inflow) or from areas at the periphery of the lake in close proximity to what appears to be inflow channels from aerial photos (Inflow 2 and Inflow 3). The Inflow 2 and Inflow 3 "channels" were not accessible by canoe d[illegible]ng 2016 due to reduced water levels and/or vegetation, and therefore, samples were collected at th[illegible] mouth of the inflow channels. Water was also sampled periodically from the center of each lake. Th[illegible]se samples were collected to evaluate the general water qu[illegible] description of e[illegible]h of the sampling sources, with the exception of the lake m[illegible]ided here:

<u>Inflow 1</u> – corresponds to the discharge of the Sand River into [illegible]f Little Sandy Lake. Water quality samples are collected from the inflow cha[illegible]et downstream of a wooden suspension snowmobile bridge crossing the Sand [illegible]



N

0 375 750 1,500
Feet
1 Inch = 750 Feet

Legend

- ▲ Inflow Water Sample
- ◉ Outflow Water Sample
- ■ Lake Middle Water Sample

Figure 3
Twin Lakes 2016 Inflow/Outflow Water Sampling Locations

Twin Lakes
US Steel Corporation - Minnesota Ore Operations
Mt. Iron, Minnesota (St. Louis County)

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Date Drawn: December 7, 2016		3
Drawn By: Evan Johnson		
NTS Project #: 10170E		

Inflow 2 – represents flow entering Little Sandy Lake from a wetland complex to the west southwest that originates near the northeast corner of the Minntac tailings basin perimeter dike. The Inflow 2 sampling location is situated on the west side of Little Sandy Lake at the mouth of an east / west trending wetland flow channel.

Inflow 3 – represents discharge to the system from general wetlands present north of Little Sandy Lake. The Inflow 3 sampling location is situated on the northwest side of Little Sandy Lake at the mouth of a north / south trending flow channel running through this wetland complex.

Culvert Inflow – represents tributary flow from the north entering the east end of Sandy Lake near the discharge into the Sand River. A culvert was identified in 2014 on a stream that appeared to be the main source of flow to this tributary (previously referred to as "Outflow Trib 1"). The culvert is located roughly 1080 meters upstream from where the tributary discharges into Sandy Lake. Water quality sampling results from 2014 showed that there were no significant differences between the Outflow Trib 1 and Culvert Inflow samples, and therefore all subsequent sampling for this source has been conducted at the culvert.

Sandy Lake South Inflow – represents tributary inflow from the south entering the southeast arm of Sandy Lake. This sampling point was identified during the aquatic plant survey (see Section 2.7), after which water quality sampling was implemented.

Twin Lakes Outflow – is located in the Sand River channel approximately 450 meters downstream from the mouth of the north tributary (characterized by Culvert Inflow / Outflow Trib 1). Water sampled at this location is representative of the total outflow from the Twin Lakes system.

As described in the Plan and detailed below, water samples were routinely obtained from the three inflow sources to Little Sandy Lake, the inflow to Sandy Lake (Culvert Inflow) and outflow from the system (Twin Lakes Outflow). Analytical results from these monthly sampling events, as well as the mid lake samples and data from the Sandy Lake South Inflow, were tabulated by Event Date, as well as by Sample Location, and are presented in Appendix C. In addition, summaries of the sampling results from selected monitoring locations for each of the three years of Plan implementation are presented in Tables 1 – 3 below.

2.6 Twin Lakes Inflow / Outflow Flow Measurements

Flow measurements were collected concurrent with Twin Lakes water quality sampling events at the Inflow 1, and Culvert Inflow sample locations. Sand River flow was also monitored at the Station 701 monitoring location, i.e., the point at which the Sand River crosses under County Road 306 immediately upstream of U.S. Highway 53, during each sampling event. Discharge through each of the three monitoring locations was gauged using a Marsh-McBirney Model 2000 Flo-Mate to obtain current velocity values at specific cross-sectional intervals. The results of the 2016 monthly discharge monitoring can be found in Table 4.

It should be noted that flow rates for Inflow 1 are measured at the downstream (north) side of the snowmobile bridge crossing the Sand River at the inlet to Little Sandy Lake. It should also be noted that even though it appears from aerial photographs that defined flow channels exist in the two wetlands

Table 1. Twin Lakes Water Quality 2016

Analytes - Cations	Reporting Units	Little Sandy Inflow 1			Little Sandy Inflow 2			Little Sandy Inflow 3			Little Sandy Middle			Sandy Middle			Twin Lakes Outflow			Culvert Inflow		
		Average	Min	Max	Average	Min	Max	Average	Min	Max	Average	Min	Max	Average	Min	Max	Average	Min	Max	Average	Min	Max
Aluminum	µg / L	96	<50.0	284	28	<50.0	111	11.5	<50.0	69.1	<50.0	<50.0	<50.0	<50.0	<50.0	<50.0	19.0	<50.0	57.3	16.4	<50.0	132
Calcium	mg / L	55.9	39.4	69.6	39.0	30.7	47.4	34.4	30.1	40.0	35.0	28.2	46.0	36.3	31.5	38.7	27.8	24.3	33.4	12.0	10.0	14.2
Iron	µg / L	4842	1150	20700	1155	442	2320	1060	268	3270	388	388	388	650	650	650	1553	502	3280	5498	1560	10700
Magnesium	mg / L	75.1	45.6	99.3	54.4	41.9	69.1	50.9	47.5	56.0	32.0	38.3	67.2	49.7	42.9	55.6	36.0	31.2	46.5	4.2	3.7	4.9
Manganese	µg / L	177	81.3	429	121	51.9	214	127	77.2	220	63.3	63.3	63.3	38.4	38.4	38.4	85.6	46.8	138	233	62.9	419
Potassium	mg / L	6.0	2.6	9.5	3.4	2.3	4.6	2.7	1.5	4.3	3.5	2.9	4.1	3.3	3.0	3.6	2.9	2.2	3.5	1.4	0.94	1.8
Sodium	mg / L	29.6	17.1	39.0	17.3	14.3	23.0	13.5	9.2	16.8	16.6	13.5	23.0	17.1	15.2	20.1	13.1	11.5	17.1	3.8	3.1	4.2
Analytes - Anions																						
Chloride	mg / L	43.6	20.9	56.5	23.9	17.9	33.7	18.0	12.5	21.7	23.8	17.8	34.7	24.3	18.4	30.2	19.2	15.4	26.1	9.1	7.1	10.6
Nitrogen, Kjeldahl, Total	mg / L	0.93	<0.60	2.6	1.2	0.70	2.1	1.0	0.60	1.6	0.72	<0.50	1.4	0.70	0.79	1.3	0.87	<0.50	1.5	0.49	<0.50	1.3
Ammonium as Nitrogen	mg / L	0.06	<0.10	0.36	0.09	0.15	0.29	0.06	<0.10	0.16	0.05	<0.10	0.15	0.04	<0.10	0.11	0.11	<0.10	0.32	0.02	<0.10	0.12
Sulfate	mg / L	251	120	338	155	96.7	216	112	39.6	163	145	104	176	148	125	183	92.3	64.3	114	0.4	<2.0	2.3
Analytes - Other																						
Total Dissolved Solids	mg / L	660	431	836	465	407	561	409	367	473	439	363	548	421	389	460	330	276	392	133	113	155
Total Suspended Solids	mg / L	4.7	1.5	14	7.5	<2.5	22.0	3.5	<2.5	6.5	2.5	2.0	3.2	0.9	<1.0	1.6	2.0	<1.0	3.6	9.4	3.2	26
Alkalinity, Total as CaCO3	mg / L	196	149	278	192	120	251	198	140	255	148	106	222	151	127	179	128	92.4	152	39.7	34.8	48.4
Dissolved Organic Carbon	mg / L	25.7	10.5	63.7	27.8	15.6	38.9	28.2	16.2	38.2	21.6	21.6	21.6	25.1	25.1	25.1	24.9	14.8	39.1	21.8	11.7	35.4
Total Hardness	mg / L	449	286	582	322	249	402	295	280	330	287	228	392	295	255	326	230	189	349	47.1	40.4	55.5
YSI Probe Plus Data																						
pH	Units	7.1	6.7	7.3	7.2	6.9	7.8	7.2	7.2	7.4	7.8	7.3	8.2	7.8	7.3	8.1	7.5	7.3	7.6	6.8	6.5	7.3
Temperature	°C	15.2	5.8	21.4	16.9	6.0	24.2	16.0	5.4	23.6	18.4	7.6	25.1	18.0	7.3	24.8	16.7	6.5	25.0	15.4	5.8	20.0
Specific Conductance	uS / cm	915	547	1141	628	572	781	560	517	644	655	567	732	534	459	619	439	359	527	160	102	417

Note: Little Sandy Middle and Sandy Middle Locations were sampled only once for Aluminum, Iron, Manganese, Potassium and Dissolved Organic Carbon and there were three monthly events where Total Suspended Solids, Nitrogen-Kjeldahl and Ammonium as Nitrogen were analyzed. For the sampling frequency at each location, please review the Twin Lakes 2016 Inflow/Outflow Water Sampling Data in Appendix C.

Table 2. Twin Lakes Water Quality 2015

	Reporting	Little Sandy Inflow 1			Little Sandy Inflow 2			Little Sandy Inflow 3			Little Sandy Middle			Sandy Middle			Twin Lakes Outflow			Culvert Inflow		
Analytes - Cations	Units	Average	Min	Max	Average	Min	Max	Average	Min	Max	Average	Min	Max	Average	Min	Max	Average	Min	Max	Average	Min	Max
Aluminum	µg / L	69	29.7	124	15.4	10.1	54 3	<10.0	<10.0	16.4	<0.10	<0.10	<0.10	8.0	<50.0	18.1	14.3	<50.0	35.8	25.4	<50.0	53.0
Arsenic	µg / L	<0.05	<0.05	<0.05	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	NM	NM	NM	NM	NM	NM	<0.50	<50.0	<0.50	0.38	<0.50	0.76
Barium	µg / L	19.0	19.0	19.0	23.7	23.7	23 7	26.5	26.5	26.5	NM	NM	NM	NM	NM	NM	24.4	24.4	24.4	17.5	17.5	17.5
Calcium	mg / L	64	38.4	91.7	45.7	27.9	68.0	40.0	30.5	53.1	49.6	40.7	59.1	39.4	33.4	47.4	33.6	15.6	42.2	12.1	9.0	15.4
Iron	µg / L	963	407	2030	995	218	4170	235.7	80.0	448.0	121	121	121	268	171	315	583	287	1200	2600	1180	3800
Magnesium	mg / L	90	53	133	65.7	38.2	97	60.2	46.5	79.8	71.7	57.7	83.9	57.2	47.2	69.5	45.6	14.3	59.1	4.3	3.2	5.3
Manganese	µg / L	154	28.5	309	76.5	32.8	128	93.9	14.8	258	98.7	98.7	98.7	68.2	40.1	129	52.1	32.6	67.5	134	46.1	210
Phosphorus	mg / L	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	NM	NM	NM	NM	NM	NM	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Potassium	mg / L	7.6	5.6	11.6	4.1	1.78	5.73	3.2	1.6	4.4	5.1	5.1	5.1	4.4	4.1	4.8	4.2	1.8	6.0	1.5	1.2	1.9
Rubidium	µg / L	2.9	2.8	2.9	3.0	3.0	3.0	2.5	2.4	2.6	NM	NM	NM	NM	NM	NM	2.8	2.8	2.8	1.3	1.2	1.4
Sodium	mg / L	36.3	21.3	52.4	21.6	13.7	30.6	17.8	11.1	25.5	26.0	20.2	31.3	21.9	17.9	26.5	18.1	6.9	23.2	4.2	3.7	4.7
Strontium	µg / L	152	129	175	130.5	128	133	102	101	102	NM	NM	NM	NM	NM	NM	122	107	136	39.7	34.3	45.1
Analytes - Anions																						
Chloride	mg / L	54	31.4	85.4	30.7	23.6	43.5	23.2	13.2	33.9	37 8	31.4	47.6	32.2	28.5	39.1	27.0	12.1	35.4	10.5	8.2	13.4
Nitrogen, Kjeldahl, Total	mg / L	0.68	<0.50	0.98	1.1	0.73	1.6	0.90	0.59	1.2	0 85	0.72	1.1	0.85	0.65	1.1	0.71	0.57	1.0	0.40	<0 50	0.83
Ammonium as Nitrogen	mg / L	0.02	<0.10	0.10	0.03	<0.10	0.17	0.05	<0.10	0.12	<0.10	<0.10	<0.10	0.2	0.2	0.2	<0 10	<0.10	<0.10	<0.10	<0.10	<0.10
Sulfate	mg / L	326	191	498	227	157	340	179	52.5	250	240	219	279	187	162	223	146	33.8	200	2.5	<2.0	2.8
Analytes - Other																						
Total Dissolved Solids	mg / L	747	457	1040	549	399	737	473	309	623	572	475	649	467	399	546	388	174	473	121	95.0	166
Total Suspended Solids	mg / L	1.8	<1.0	3.6	1.7	<1.0	3.5	1.3	1.6	2.0	1.2	1.2	3.2	1.6	<1 0	4.0	1.9	<1.2	4.0	3.3	1.2	5.2
Alkalinity, Total as CaCO3	mg / L	162	93.1	233	143	105	221	148	92.6	201	145	110	178	117	93 7	153	97.5	47.4	134	36.7	24.6	46.2
Dissolved Organic Carbon	mg / L	14.3	9.4	18.4	19.4	12.9	28.5	20.5	14.7	30.7	18.3	17.0	20.1	18.8	17.0	20.3	16.2	10.8	19.3	12.8	7.5	16.3
Total Hardness by 2340B	mg / L	529	314	776	385	227	569	348	268	461	419	339	493	334	278	405	272	97.9	349	47.9	35.7	60.6
UV Absorbance @ 254 nm	cm^{-1}	0.466	0.429	0.502	0.476	0.408	0.544	0.574	0.468	0.679	NM	NM	NM	NM	NM	NM	0.422	0.360	0.484	0.525	0.478	0.572
SUVA	L / mg*m	3.5	3.4	3.5	3.3	3.3	3.3	3.4	3.3	3.4	NM	NM	NM	NM	NM	NM	3.4	3.3	3.5	4.5	4.4	4.6
YSI Probe Plus Data																						
pH	Units	7.3	6.9	7.7	7.5	7.0	7.8	7.5	6.9	8.1	8.1	7.9	8.4	8.0	7.8	8.2	7.7	7.0	8.1	6.9	6.7	7.1
Temperature	°C	13.6	6.9	19.7	15.5	6.3	22.1	13.9	7.3	21.6	16.4	7.3	22.3	16.1	6.6	22.7	15.4	6.4	23.1	13.5	7.3	18.8
Specific Conductance	uS / cm	1038	632	1435	842	703	1150	698	476	943	831	730	949	670	610	746	554	219	698	112	85.0	130

Note: To find each location's frequency of sampling, please review the 2015 Twin Lakes WRROP Annual Report under Twin Lakes Inflow/Outifow Water Sampling Data.

Table 3. Twin Lakes Water Quality 2014

	Reporting	Little Sandy Inflow 1			Little Sandy Inflow 2			Little Sandy Inflow 3			Little Sandy Middle			Sandy Middle			Twin Lakes Outflow			Culvert Inflow		
Analytes - Cations	Units	Average	Min	Max	Average	Min	Max	Average	Min	Max	Average	Min	Max	Average	Min	Max	Average	Min	Max	Average	Min	Max
Aluminum	µg / L	27.0	<20.0	52.0	15.8	<20.0	41.7	<20.0	<20.0	<20.0	30.6	30.6	30.6	37.7	37.7	37.7	20.2	22.8	35.1	NM	NM	NM
Arsenic	µg / L	0.75	<0.50	0.75	0.4	<0.50	1.1	0.60	<0.50	0.69	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0.60	0.51	0.92	0.72	<0.50	1.10
Barium	µg / L	37.9	23.1	58.9	26.6	19.4	35.4	29.2	22.3	35.5	23.3	23.3	23.3	21.4	21.4	21.4	25.5	18.9	31.2	31.2	23.9	38.2
Calcium	mg / L	66.9	37.5	95.0	32.5	25.4	40.5	33.4	24.6	44.4	29.5	29.5	29.5	25.3	25.3	25.3	24.1	19.1	34.8	13.1	11.0	15.5
Iron	µg / L	860	229	1980	543	169	1100	258	173	459	717	717	717	800	800	800	975	409	1470	4646	1870	7520
Magnesium	mg / L	92.5	44.3	140	42.8	34.4	52.8	44.7	36.1	62.3	36.5	36.5	36.5	30.5	30.5	30.5	27.4	19.7	44.9	4.4	3.9	5.2
Manganese	µg / L	142	54.4	347	56.5	23.9	92.2	75.4	25.5	127	42.7	42.7	42.7	42.5	42.5	42.5	64.8	27.6	138	183	82.3	300
Phosphorus	mg / L	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Potassium	mg / L	6.1	2.5	11.4	3.3	1.7	4.0	3.2	2.2	3.7	3.7	3.7	3.7	3.5	3.5	3.5	2.9	2.2	3.4	1.4	0.93	1.9
Rubidium	µg / L	2.9	2.0	4.0	2.3	1.5	2.6	2.6	2.3	3.0	2.6	2.6	2.6	2.5	2.5	2.5	2.1	1.6	2.5	0.90	1.1	1.4
Sodium	mg / L	38.3	18.4	58.2	15.5	12.0	19.5	14.3	9.3	23.1	12.9	12.9	12.9	11.8	11.8	11.8	10.9	8.3	17.8	4.0	3.2	4.5
Strontium	µg / L	238	133	327	112	85.5	142	114	78.2	154	98.5	98.5	98.5	86.3	86.3	86.3	85.8	66.5	123	54.6	44.2	63.4
Analytes - Anions																						
Chloride	mg / L	57.3	9.5	103	21.3	15.8	28.5	21.3	8.0	30.1	17.1	17.1	17.1	15.7	15.7	15.7	16.6	13.3	25.8	10.3	6.4	13.1
Nitrogen, Kjeldahl, Total	mg / L	0.4	<0.50	0.75	0.92	0.66	1.2	1.0	0.59	1.8	0.72	0.72	0.72	0.74	0.74	0.74	0.70	<0.50	1.2	1.1	0.9	1.2
Ammonium as Nitrogen	mg / L	<0.50	<0.50	<0.50	<0.050	<0.050	<0.050	<0.050	<0.050	<0.50	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Sulfate	mg / L	328	107	540	125	89.3	162	104	9.9	156	121	121	121	98.6	98.6	98.6	80.3	44.6	124.0	0.60	<2.0	<2.0
Analytes - Other																						
Total Dissolved Solids	mg / L	829	431	1170	403	333	465	407	318	489	366	366	366	315	315	315	299	221	375	151	114	192
Alkalinity, Total as CaCO3	mg / L	191	95.7	259	142	69.0	253	132	90.2	188	95.3	95.3	95.3	74.1	74.1	74.1	85.9	53.4	129	38.2	32.1	45.9
Dissolved Organic Carbon	mg / L	16.6	10.3	20.5	22.7	15.6	26.5	24.3	20.2	28.6	22.0	22.0	22.0	22.0	22.0	22.0	21.8	16.7	26.2	20.5	8.5	30.4
Total Hardness by 2340B	mg / L	548	276	814	257	207	317	267	210	368	224	224	224	189	189	189	173	132	272	50.8	43.7	60.0
UV Absorbance @ 254 nm	mg / L	0.672	0.320	0.930	0.896	0.561	1.20	1.01	0.781	1.40	0.958	0.958	0.958	0.938	0.938	0.938	0.890	0.570	1.10	1.02	0.360	1.90
SUVA	cm^{-1}	3.9	3.1	4.5	3.9	3.6	4.6	3.8	2.3	4.7	4.4	4.4	4.4	4.3	4.3	4.3	4.2	3.6	5.0	3.9	1.3	5.2
YSI Probe Plus Data																						
pH	Units	7.4	7.0	8.6	7.5	6.6	8.4	7.8	6.9	8.5	7.6	7.6	7.6	7.7	7.7	7.7	7.6	7.0	8.6	6.6	6.6	6.8
Temperature	°C	16.3	7.2	21.7	16.3	7.7	23.4	19.7	7.3	25.2	23.6	23.6	23.6	22.6	22.6	22.6	17.5	7.9	23.1	16.6	7.3	23.9
Specific Conductance	µS / cm	1098	569	1620	546	261	689	542	364	678	504	504	504	387	387	387	381	307	561	117	96.0	137

Note: To find each location's frequency of sampling, please review the 2014 Twin Lakes WRROP Annual Report under Twin Lakes Inflow/Outlfow Water Sampling Data.

Table 4. 2016 Twin Lakes Measured Inflows & Outflows (gpm)

Date Measured	Inflow 1 to LSL	Tributary to SL Culvert Inflow	Total Measured Flow into Twin Lakes	Sand River (Station 701)	Measured In vs. Total Out
5/26/2016	1,047	327	1,374	5,075	27%
6/24/2016	2,893	466	3,359	13,977	24%
7/22/2016	3,920	568	4,488	11,859	38%
8/25/2016	1,257	440	1,697	6,083	28%
9/28/2016	5,000	568	5,568	10,341	54%
10/20/2016	1,450	466	1,916	7,877	24%

Notes:
1) During the August 25th monitoring event, a separate tributary stream was identified on the south side of Sandy Lake. The flow was estimated to be 15 gpm at that time.
2) Flow was not measured at the Inflow 2 or Inflow 3 monitoring locations - to date no defined flow channel has been identified.

terminating at Inflow 2 and Inflow 3, it was not possible to gauge flow rates into Little Sandy Lake at these selected monitoring locations. Efforts to establish flow monitoring stations were negated by the absence of a defined channel and / or safe access issues. It appears that during the majority of the year, there is little concentrated flow within the two wetland channels feeding the Inflow 2 and Inflow 3 monitoring locations, and overall inputs are diffuse, entering the lake at multiple points across the width of the wetland complexes. Readily measurable flow in the defined wetland channels likely only occurs during larger precipitation and runoff events.

Unlike Inflow 2 and Inflow 3, flow from the Sandy Lake South Inflow is contained in a defined channel. However, safe access to this tributary is limited, and therefore, gauging of input flows via flowmeter was not possible. Instead, a visual estimate of inflow was recorded during each water quality sampling event.

As can be seen in the flow summary table presented above, the measurable sources of inflow that contribute to discharge of the Sand River at the outlet of Sandy Lake did not match concurrent discharges measured at Station 701. In general, there is considerably more discharge downstream in the Sand River than can be accounted for from the five main inflow sources. Of the six flow measurement events completed in 2016 all but two (July 22 and September 28) represented roughly 24 – 28% of the known flows to Station 701. The discrepancies in the flow balances for July and September (38% and 54% respectively) can be attributed to the inability to measure flow rates from the wetland channels discharging into Little Sandy Lake at the Inflow 2 and Inflow 3 sampling locations, as well as the contributions from the Sandy Lake South Inflow. However, it is believed that the discharge from these inputs is relatively minor in comparison to Inflow 1. A much more significant factor is the unnamed stream that is tributary to the Sand River between the outlet of Sandy Lake and Station 701, which drains a relatively large area to the east and south of the Twin Lakes. Monitoring of this source is currently outside the scope of the Plan. It is likely that during wetter periods of the year this tributary represents a significant contribution to the discharge through Station 701, but only a minor contribution during drier periods.

Opportunities for measuring the flow out of Sandy Lake at the Twin Lakes Outflow sampling location were evaluated early in the 2016 monitoring season. However, no obvious alternatives were identified. The rate of outflow at this location remains a significant gap in the data set and therefore, additional efforts will be directed at establishing a safe means of gauging flow through the channel at this or an alternative nearby downstream location.

2.7 Twin Lakes Aquatic Plant Survey

The Twin Lakes Aquatic Plant Survey that took place in August 2016 marks the third year the type of vegetation growing in Sandy and Little Sandy Lake was determined.

The sampling method used is a part of the United States Environmental Protection Agency (EPA) 2012 National Lakes Assessment and there were two references used to categorize the various aquatic plants: 1) Borman, Susan, et al. *Through the Looking Glass...A Field Guide to Aquatic Plants Second Edition,* Wisconsin Lakes Partnership, 1997. 2) Eggers, Steve D., and Donald M. Reed. *Wetland Plants and Plant Communities of Minnesota and Wisconsin.* U.S. Army Corps of Engineers, St. Paul District, 1997. First, four transects were defined in different areas of each lake. Between four and seven locations were sampled on each of the transects. Sampling locations were randomly located along each transect. Aquatic plant samples along each transect were collected (see Appendix D) until about the middle of the lake was reached. The GPS location of each sample site was obtained. Figure 4 details the vegetation sampling transects and sampling locations.

A double headed sampling rake on a rope was tossed off the left side of the canoe and retracted. The percent plant density on the rake was recorded along with the plant taxa and the percent of the sample of each taxon. Aquatic macrophytes were field-identified and listed in Appendix D. Photos of aquatic plants retrieved during the survey are contained in Appendix E.

Below is a summary of the aquatic macrophytes collected on both lakes:

Common Name	Scientific Name
Coontail	*Ceratophyllum demersum*
White Water Lily	*Nymphaea odorata*
Fries Pondweed	*Potamogeton robbinsii*
Northern Water Milfoil	*Myriophyllum exalbescens*
Musk grass	*Chara spp.*
Sago pondweed	*Stuckenia pectinata*
Clasping pondweed	*Potamogeton richardsonii*
Stiff pondweed	Potamogeton strictifolius
Common (American) Bur-reed	*Sparganium eurycarpum*
Filamentous algae	
Wild Celery	*Vallisneria americana*
Northern Bladderwort	*Utricularia intermedia*
Spatterdock	*Nuphar variegata*

Note: wild rice was observed naturally growing at the SLT3 station 1 survey location, but was not sampled as part of the Aquatic Plant Survey.

The water depth ranged from 1.0 feet to 4.75 feet depending on where the narrow leaved cattail (*Typha angustifolia*) beds started around the inner periphery of each lake. The deepest location sampled on Sandy Lake was 4.5 feet. Not much vegetation was sampled at this depth. The deepest location sampled on Little Sandy was 4.75 feet. However, after 4.0 feet not much vegetation was found. Very little 'die back' of vegetation was observed due to the time of year that the lakes were surveyed. All of the aquatic macrophytes sampled are taxa native to Minnesota.

Water depth measurements obtained during the 2016 aquatic plant survey were used to construct bathymetric maps of Little Sandy and Sandy Lakes (Figure 5).

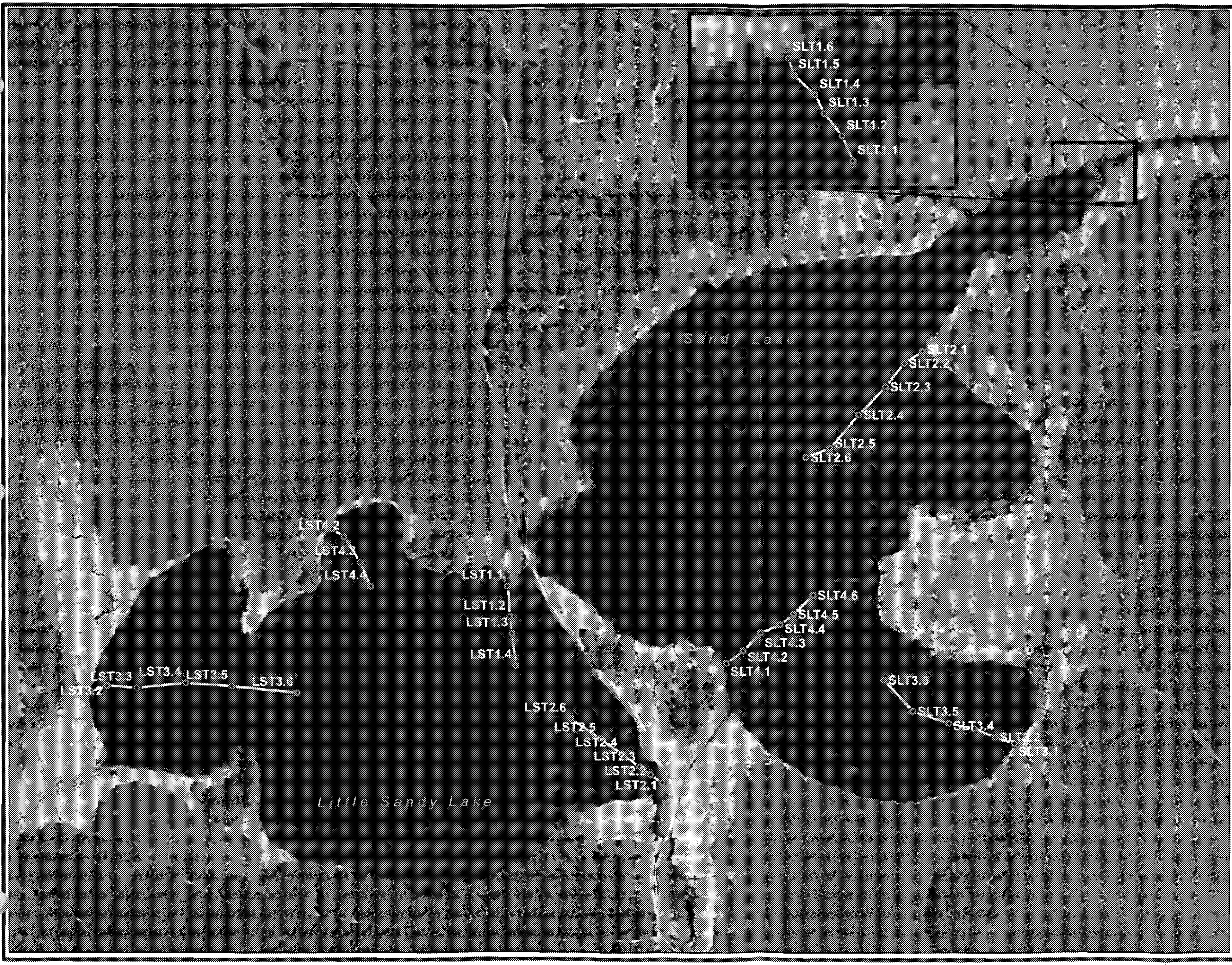
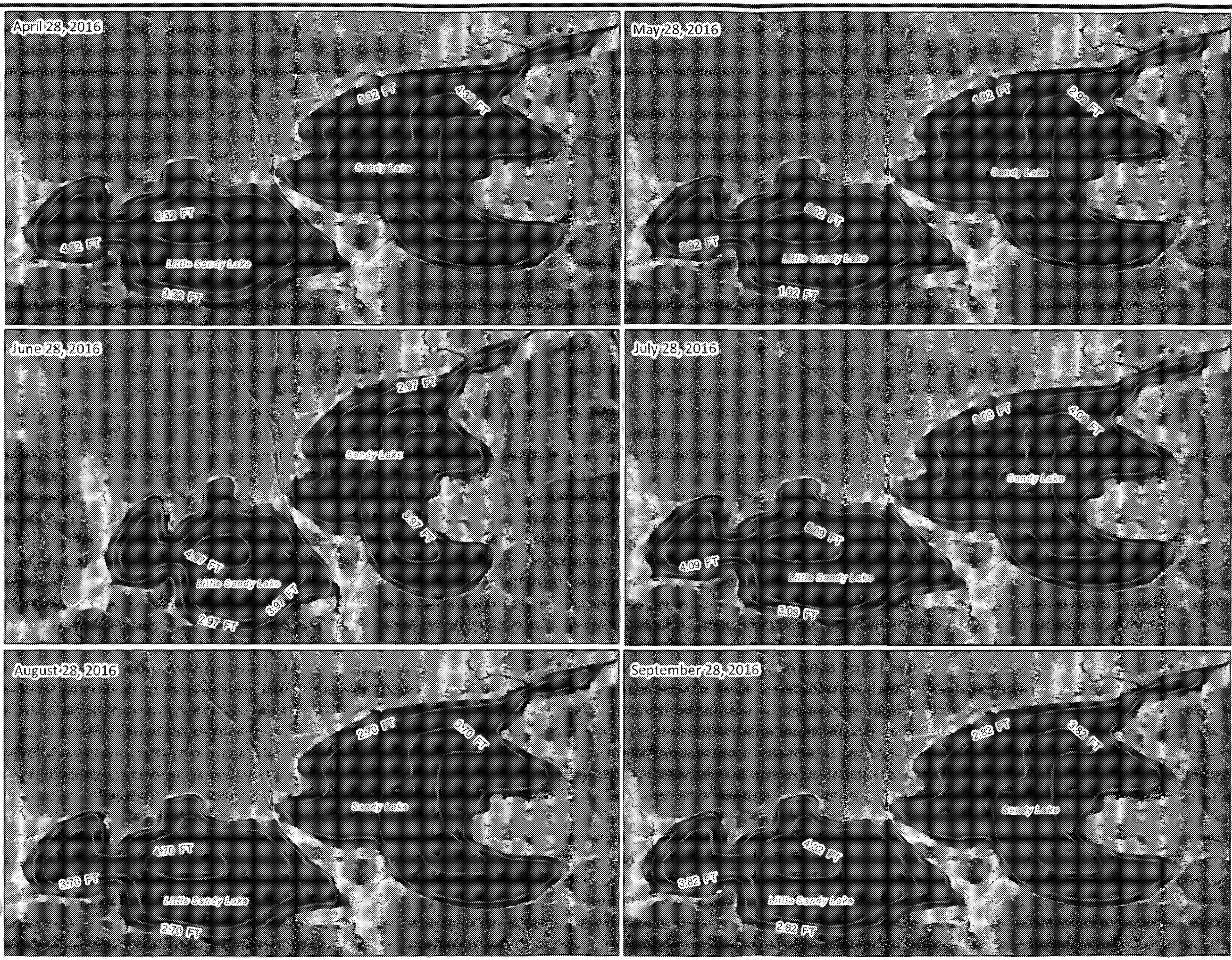


Figure 4
Twin Lakes 2016 Aquatic Plant Survey Transect Locations

Twin Lakes Survey
US Steel Corporation-
Minnesota Ore Operations
Mt. Iron, Minnesota (St. Louis County)

www.netechnical.com

Date Drawn: November 14, 2016	4
Drawn By: Evan Johnson	
NTS Project #: 10170E	



N

0 600 1,200 2,400

Feet

1 Inch = 1,228 Feet

Legend

Twin Lakes Bathymetry

Notes:

-Bathymetry lines were created by interpreting depths collected during monthly vegetation surveys. True bathymetry may differ from drawn contours.

-The water depth was corrected to match the 2015 water depth using bridge transducer data.

-The water depth according to the Bridge Transducer on August 18, 2015 was 2.40 feet.

Figure 5
2016 Twin Lakes Bathymetry

Twin Lakes Survey
US Steel Corporation-
Minnesota Ore Operations
Mt. Iron, Minnesota (St. Louis County)

www.netechnical.com

Date Drawn : November 30, 2016

Drawn By : Evan Johnson

NTS Project #: 10170E

5

2.8 Sand River (and Twin Lakes) Beaver and Dam Removal Activities

During the first full year of Plan implementation (2014), a private animal control contractor was hired to remove beaver and open dams downstream of the Twin Lakes. The effort resulted in measurable, albeit limited, success. As described in the 2014 Annual Report, dams downstream of the Twin Lakes were opened on three separate occasions (May, late June and late September) and there were indications of positive (downward) water level responses each time, as reflected in water depth measurements at the steel bridge. However, in each case beaver returned and rebuilt the dams, resulting in increased lake levels.

Since water depth has been identified as a critical factor in wild rice success, U. S. Steel contracted with a U.S. Department of Agriculture (USDA) Animal and Plant Health Inspection Service (APHIS) crew based in Grand Rapids, MN, to conduct an intensive beaver and dam removal program in 2015. This effort resulted in the removal of an estimated 60 beavers by either the APHIS crew or by private trappers. The APHIS crew noted the presence of up to 30 dams along the Sand River downstream of Sandy Lake and removed an unspecified number of dams, both via explosives and by hand.

In 2016, the APHIS Crew evaluated the beaver presence two separate times (once in May and the other in August). Their conclusion was that beaver had not returned and were not a threat for the moment. However, in aggregate, the old beaver dams and associated channel debris are causing water levels to be held up in the system, especially after significant rainfall events, as evidenced by the pressure transducer data from the steel bridge. It will be difficult to maintain water levels in the Twin Lakes at optimum depths for consistent wild rice growth given the large number of relic dams and pinch points currently present in the Sand River channel between Sandy Lake and U.S. Hwy 53. This is especially critical during wetter years, as was the case for 2016.

2.9 Results of 2015 Wild Rice Pilot Seeding Efforts

As described in the 2015 Annual Report, seeding of three separate areas in each of the two lakes was undertaken in late October 2015 to determine the potential for wild rice growth. The areas were identified for seeding based on previous known wild rice areas, and appropriate existing water depths and sediment type (i.e., organic substrate). A couple of the seed plots were subsequently moved from the original plan based on input from area locals familiar with the lakes. Figure 6 shows locations of the wild rice seeding plot locations within the Twin Lakes.

Four of the six seed plots produced variable amounts of emergent wild rice, with two of the six demonstrating fairly good growth (see Appendix E for photos of the wild rice seed plots and Appendix G for estimates of wild rice densities). The two seed plots on the north side of Little Sandy Lake either showed zero or very sparse growth. Interestingly, the seed plot on the south side of Little Sandy Lake, close to the main inflow (Inflow 1 location) to the lake system, showed fairly strong wild rice growth. In general, there is much more aquatic plant growth in Sandy Lake than in Little Sandy, and there are portions of Little Sandy that demonstrate much more aquatic plant growth than in other areas, possibly

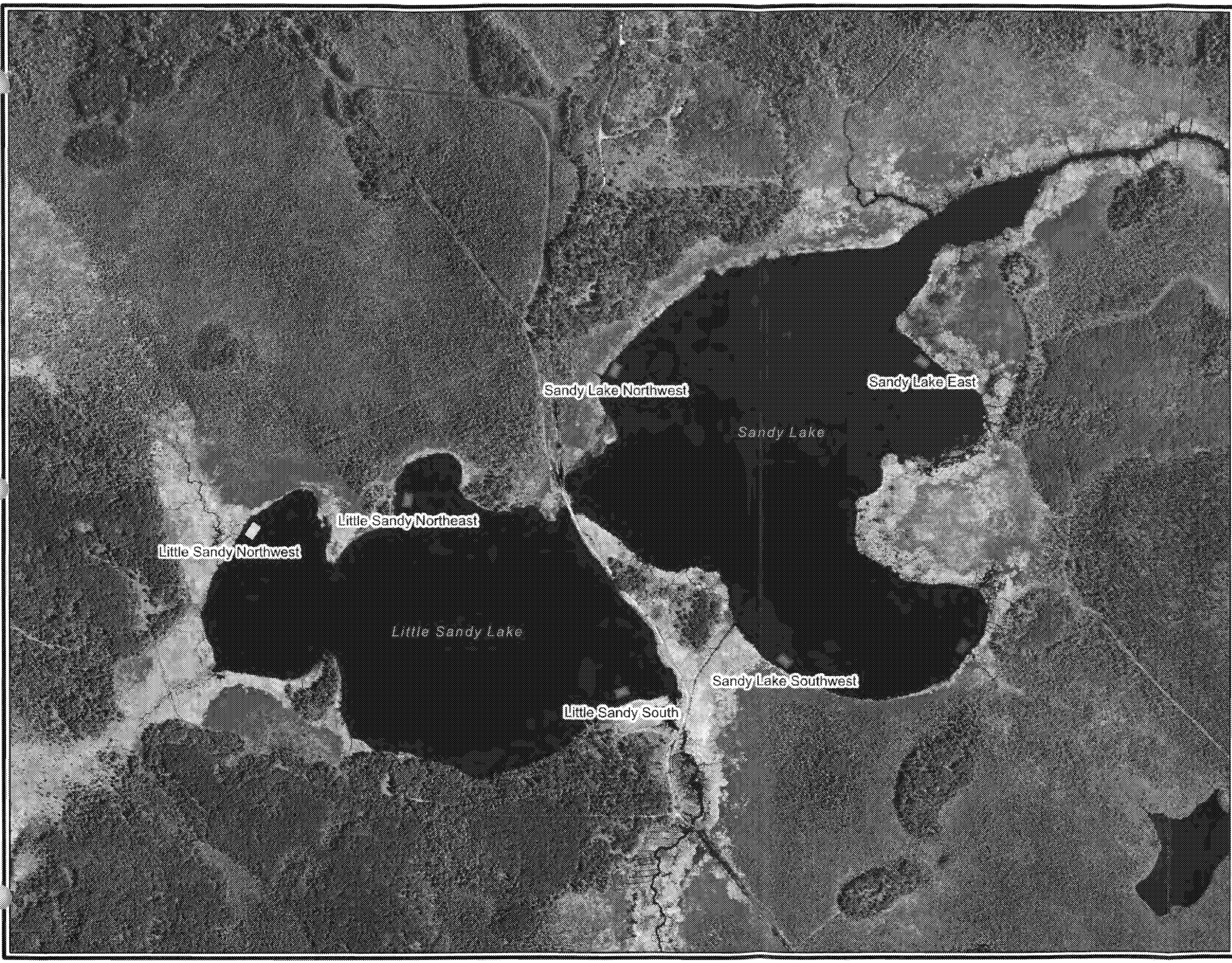


Figure 6
Twin Lakes 2016 Wild Rice Growth Areas

Twin Lakes Survey
US Steel Corporation-
Minnesota Ore Operations
Mt. Iron, Minnesota (St. Louis County)

NTS
Environmental Science & Engineering
www.ntstechnical.com

Date Drawn : November 16, 2016		6
Drawn By : Evan Johnson		
NTS Project #: 10170E		

due to the characteristics of the lakebed. There is documentation indicating that historically portions of the Twin Lakes consistently produced good stands of wild rice, while other portions of the lakes produced poorly or not at all. Therefore, it is possible, if not probable, that portions of the Twin Lakes are not suited to the production of wild rice and will not support wild rice growth due to site specific conditions unrelated to water quality or water depth.

During the 2016 field season, wild rice test seeding plots were inspected for growth of WR plants. Floating leaf stage WR plants were observed during July 2016; and were confirmed during August 2016. WR plants in at least the floating leaf stage were observed in all three test seeding plots in Sandy Lake. Mature, aerial, seed-producing WR plants were observed in the Sandy Lake East (SLE) and Sandy Lake Southwest (SLSW) locations with ≥ 200 plants per plot area. WR plants in the floating leaf stage were observed in the Sandy Lake Northwest location, but with only about 30 – 40 plants in the entire plot. WR plants in the SLE and SLSW locations produced a sufficient number of seeds to have the capability of limited 'self-seeding' in those areas. Observance of WR plants in these two areas during future years could indicate limited self-seeding events, or germination of legacy seed in the sediment from the 2015 seeding efforts. Also within Sandy Lake a natural group of WR plants was observed near the Sandy Lake Inflow South tributary location. These plants were not part of the WR seeding effort, and were classified as a natural WR stand. These plants were also mature, seed producing plants capable of a limited self-seeding event in the area. It was estimated that a total of 15 – 20 natural wild rice plants emerged into aerial phase near the mouth of the Sandy Lake Inflow South tributary.

Three plots were also seeded with WR in Little Sandy Lake. The test plot near 'Inflow 1' contained ≥ 100 mature, seed producing WR plants. Similar to seed producing plants in two plots in Sandy Lake, seed producing plants in Little Sandy Lake had the capability for a limited self-seeding event in that area / plot. Sparse floating leaf WR plants were observed in the Little Sandy Northeast test seeding plot, with 7 – 10 plants observed in the entire area. No WR plants were observed in the Little Sandy Lake test seeding plot near 'Inflow 3' (Little Sandy Northwest).

Regardless of the lake in which they were observed, mature seed-producing WR plants appeared healthy. No indications of nutrient deficiencies such as chlorosis associated with potential nitrogen deficiency, or discoloration associated with potential phosphorus deficiency were observed; and no evidence of diseased plants was observed (e.g., fungal brown spot disease).

However, based on historical observations of WR in the Twin Lakes system, water and sediment pore water chemistry may not have been the only influence on WR growth and density. Minnesota DNR studies from 1966 indicate that only isolated areas of Little Sandy Lake contained areas of WR growth. Sandy Lake is documented to have had WR throughout the entire lake, with some areas of denser WR growth than others. One criterion of these lakes that has measurably changed since these whole-lake studies were completed is water depth throughout the entirety of each lake. During the completion of these studies, water depth throughout the Twin Lakes system did not appear to extend past three feet. Over the course of the current Twin Lakes WR Restoration Opportunities Plan study, water depths within each lake routinely exceed four feet throughout the more central areas, and surpass five feet in the most central areas in each lake. During the time period from the 1966 studies to current, WR density has decreased to the point of absence from both lakes in some years; to current very sparse 'natural' growth areas. It is possible that as water depths throughout the Twin Lakes system increased, the ability of WR to compete for light during the seedling phenological stage has been adversely influenced resulting in a nearly total lack of germination potential. However, the 2015 test plot seeding study would suggest this possibility does not entirely explain the lack of WR in other areas with similar water depths and sediment characteristics as the successful test seeding plots. Another possibility is that although WR seeds historically may have germinated, increasing water depths in early Spring resulted in decreasing success of adult plant development; this could have ultimately resulted in depletion of the sediment-associated WR seed bank throughout much of the Twin Lakes system. Overall, current physical conditions, such as water depth increases and fluctuations, within the Twin Lakes system may not be conducive to WR growth and development throughout the majority of the Twin Lakes system.

2.10 2016 Follow-on Seeding Efforts

Based on the success of the pilot seed plots that were observed throughout the 2016 growing season and described above, U. S. Steel developed plans to harvest additional wild rice from the Sand River upstream of MN Hwy 169, similar to what was completed in September 2015. However, the area experienced severe weather on the night of Labor Day, September 5, with heavy rain and strong winds. Subsequent efforts to harvest rice from that source were useless, as the wild rice plants were either uprooted, or the rice was stripped from the heads. Due to the vagaries associated with relying on this single source of seed for future planting activities, the possibility of using wild rice seed from other sources should be considered.

3.0 2017 Twin Lakes Work (Planned)

A general summary of the work proposed for 2017 in support of The Plan is shown in Appendix H. Details of the major components of the 2017 work plan are described separately below.

3.1 Rainfall, Water Level, and Temperature Monitoring

Continuous water depth measurements will again be recorded using the PT during the 2017 monitoring season (ice-out until freeze-up). The PT will be placed in the same location at the steel bridge between Little Sandy and Sandy lakes at ice-out in the Spring of 2017 as during previous deployments and will be retrieved prior to freeze-up during the Fall of 2017. Further, during each planned sampling / monitoring event, water level and temperature data will be downloaded to ensure that the data is being recorded as planned. Rainfall data will continue to be collected from the Minntac Tailings Basin weather station. This weather station was set up on the roof of the Tailings Basin Reclaim Pumphouse, which is located approximately 2 miles due south of the steel bridge. This new meteorological monitoring capability allows for more accurate measurement of local precipitation events, as well as local evaporation rate data.

3.2 Sediment Pore Water Sampling and Analysis

In order to maintain consistency of measuring characteristics of Twin Lakes sediment pore water, peepers will again be deployed in specific locations within Little Sandy and Sandy lakes. Peepers (see Figure7) are fitted with sealed 50 mL centrifuge tubes so that when deployed the centrifuge tubes are located within the top 10 cm of sediment. Each 50-mL centrifuge tube is completely filled (no headspace) with analytical standards-grade deionized water obtained from Pace Analytical Laboratories (Pace; Virginia, MN). Each tube contains a 0.45 μM pore size filter in the cap to allow for deionized water / pore water equilibration via diffusion. Using peepers to collect pore water samples for characterization can better minimize, if not eliminate, the potential for the collected pore water to be exposed to air / oxygen.

For the 2017 field season, three peepers are planned for deployment in Little Sandy Lake and an additional three peepers are planned for deployment in Sandy Lake. Peepers are scheduled for six, 30-day deployments beginning immediately following ice out. One peeper is planned to be relocated from Inflow 3 to Sandy Lake Inflow South. Locations in Little Sandy Lake will be Inflow 1, Inflow 2, and the Little Sandy Lake middle location. Locations in Sandy Lake will be Sandy Lake Outflow, Sandy Lake Middle, and Sandy Lake Inflow South.

Figure 7. Peeper sediment pore water sampling device.

As mentioned in section 2.3, peeper samples collected at the Inflow 2 monitoring location show elevated sediment pore water hydrogen sulfide concentrations, with concurrent low extractable iron concentrations, which indicates that sulfide generation in this location likely exceeds the available iron for iron sulfide precipitation. One potential tactic to mitigate the elevated pore water sulfide may be to apply zero valent iron (ZVI) to the lake sediment in an area near / within the Inflow 2 monitoring location. This effort would be outside the scope of the original Work Plan, but appears to have merit as a potential wild rice restoration opportunity specifically focused on decreasing sediment pore water hydrogen sulfide.

Following the initial peeper deployment for sediment pore water hydrogen sulfide measurement, the appropriate amount of ZVI will be calculated to transform the measured concentration of hydrogen sulfide to iron sulfide. Application of 1.5x the calculated stoichiometric amount of ZVI will be added to the test plot area to provide excess available iron for sulfide precipitation. Tentatively, the suggested time period for this ZVI application is late-Spring / early-Summer 2017, with an estimated test-plot application area of 50' x 50'.

3.3 Continued Wild Rice / Aquatic Plants Survey within Twin Lakes System

Efforts to characterize the Twin Lakes in terms of wild rice presence, and density if present, will continue during each 2017 field visit. As alluded to in Section 2.7 above, an aquatic plant survey will be completed at the height of the 2017 growing season in both Little Sandy and Sandy Lakes, likely in mid-August. Repeated aquatic plant surveys are intended to inform future wild rice restoration efforts.

3.4 Continued Inflow / Outflow Flow Measurements, Water Quality Sampling, and Characterization Efforts

Water quality and quantity sampling and monitoring will continue on a monthly basis during the 2017 field monitoring season. The monthly sampling will follow the practice established in 2014 and continued in 2015 and 2016, with one exception – Inflow 3 sampling will be eliminated from the sampling mix since there does not appear to be a significant difference in the water quality at this location in comparison to other Little Sandy Lake water column samples collected previously. Monthly water quality samples will be collected at Inflow 1, Inflow 2, the Culvert, and Twin Lakes Outflow. In addition, samples from Sandy Lake South Inflow will be collected, as well as Station 701 and the middle of each lake. However, the Station 701 and mid-lake samples will be analyzed for an abbreviated list of parameters, consisting of the major cations and anions, as well as field data.

Flow monitoring will continue at Inflow 1, the Culvert, and Station 701, and the potential for gauging flow at Sandy Lake South Inflow will be evaluated. At a minimum, a visual estimate of flow at that location will be recorded each month. An additional flow monitoring site nearer the Twin Lakes Outflow sampling location was considered in 2016. Establishment of a flow monitoring site in that area would allow for a direct measurement of outflow from Sandy Lake and provide a better overall system water balance, without influence from other Sand River inflows between Sandy Lake and the 701 monitoring location. However, no alternative flow monitoring opportunities were identified during 2016. Due to the importance of this factor, additional efforts will be directed at establishing an outlet flow gauging site near the junction of Sandy Lake and the Sand River. Water quality and flow results will be compared to previous years' data so that characterization efforts may continue.

3.5 Continued Beaver Trapping and Water Level Control

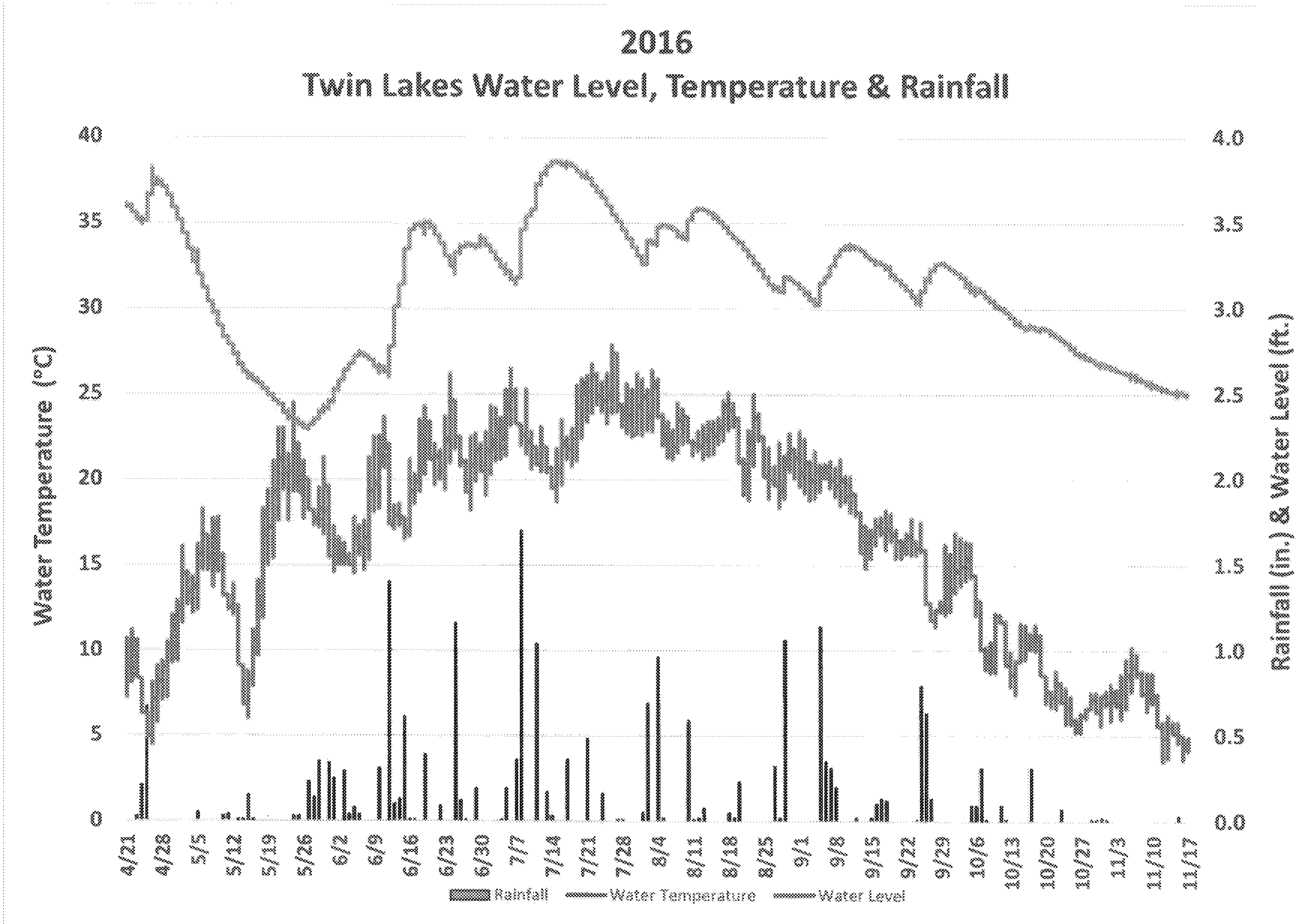
Continued management of lake water depths suitable for wild rice growth is critical to successful restoration of wild rice to the Twin Lakes system. To help ensure that flow through the lakes system is maintained, USDA APHIS will again be contracted for beaver and dam removal as needed. Specifically, the APHIS crew will be charged with removing any beaver that may have returned / moved in to the Sand River channel area, especially from the outlet of Sandy Lake downstream to approximately one mile east of U.S. Hwy 53. They will also be responsible for removing significant obstructions to flow along the Sand River mainstem soon after ice out and again during the early summer timeframe, following the period of above average rainfall typical to this area.

3.6 Consideration of Additional Wild Rice Seeding

Based on the results of the pilot-scale seeding efforts completed in October 2015 and discussed in Section 2.9 above, U. S. Steel may undertake similar seeding efforts in 2017. Although these are preliminary plans and subject to change depending upon circumstances encountered during the 2017 field season, it is envisioned that additional seeding will be pursued. However, as described in Section 2.10, efforts to collect additional seed from the Sand River on or about 9/9/16 were negated by severe weather. Serious consideration should be given to identifying alternative viable wild rice seed sources for planting activities, similar to what was undertaken in 2016 for seeding the St. Louis River estuary using wild rice from Leech Lake and White Earth sources.

APPENDIX A

2016 Twin Lakes Rainfall, Water Level, and Temperature Measurements



2016
Twin Lakes Water Level, Temperature & Rainfall
Water Temperature (°C)
Rainfall (in.) & Water Level (ft.)
40
35
30
25
20
15
10
5
0
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
4/21
4/28
5/5
5/12
5/19
5/26
6/2
6/9
6/16
6/23
6/30
7/7
7/14
7/21
7/28
8/4
8/11
8/18
8/25
9/1
9/8
9/15
9/22
9/29
10/6
10/13
10/20
10/27
11/3
11/10
11/17
Rainfall
Water Temperature
Water Level

APPENDIX B

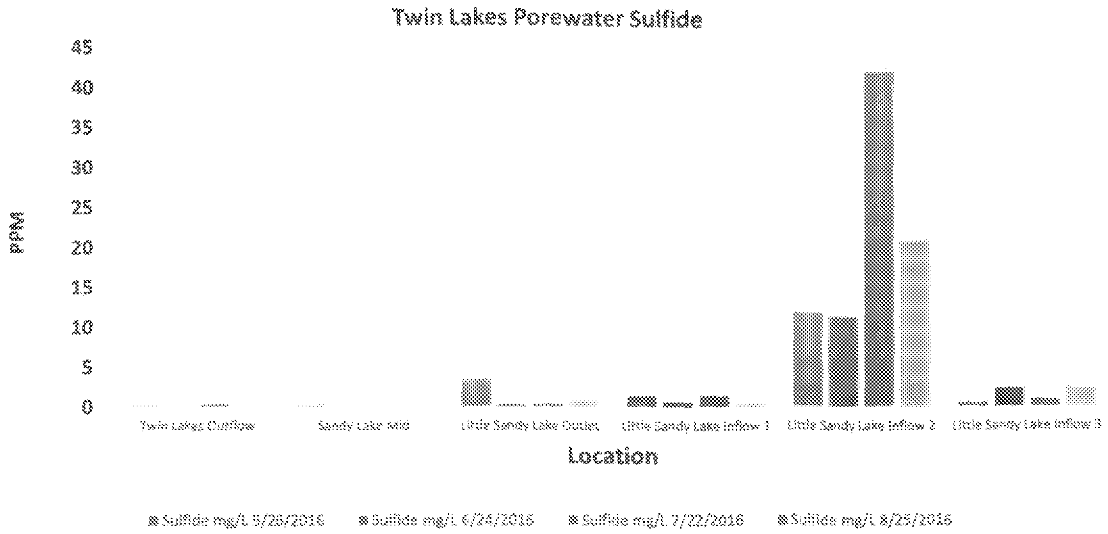
Twin Lakes 2016 Sediment Pore Water Results

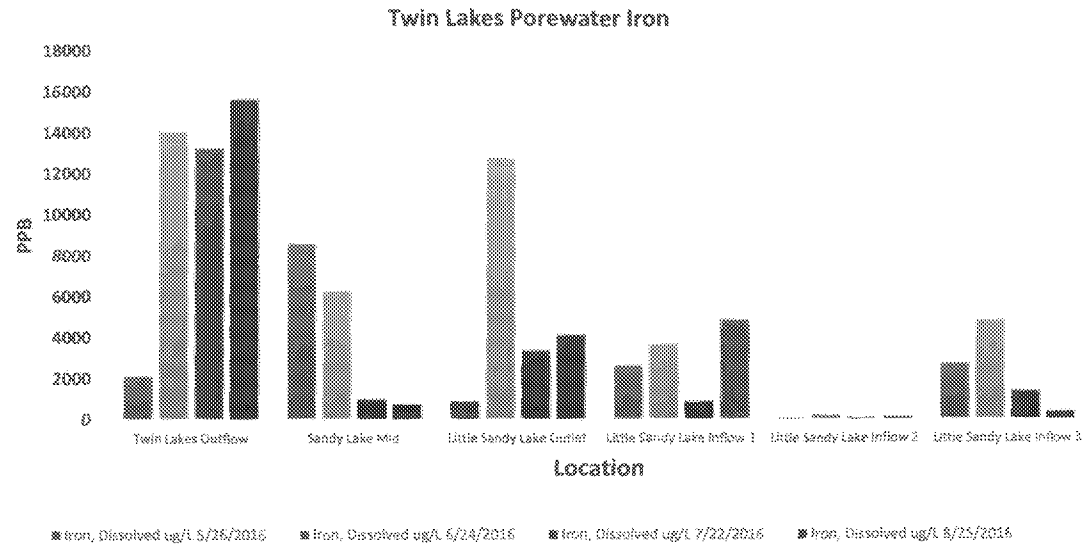
TWIN LAKES PEEPER SEDIMENT POREWATER RESULTS
2016

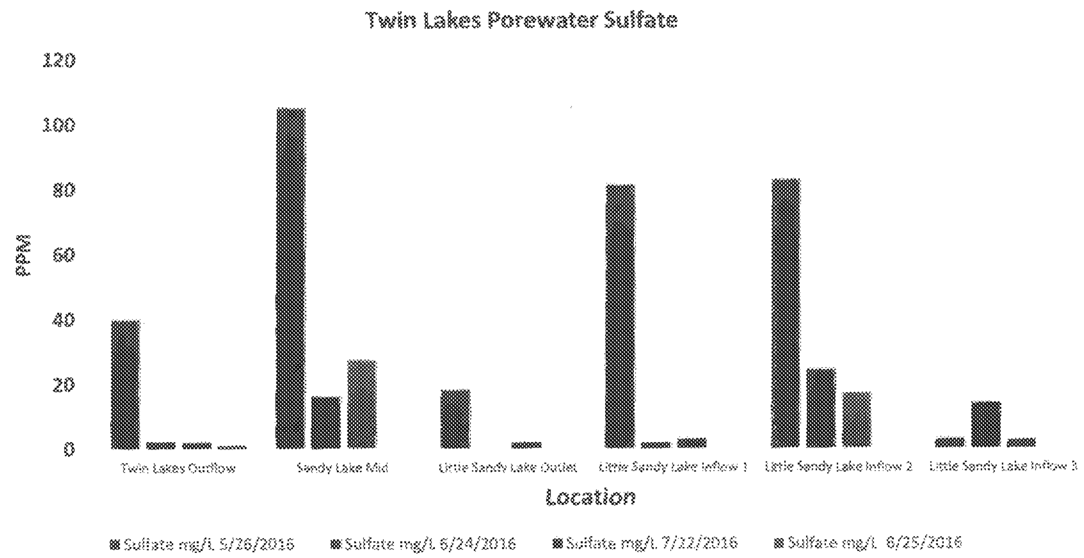
PARAMETER	UNITS	DATE	Twin Lakes Outflow	Sandy Lake Mid	Little Sandy Lake Outlet	Little Sandy Lake Inflow 1	Little Sandy Lake Inflow 2	Little Sandy Lake Inflow 3	MDL
Sulfide	mg/L	5/26/2016	0.23	0.25	3.5	1.4	11.8	0.61	Varies
		6/24/2016	0.11	0.13	0.28	0.63	11.3	2.4	
		7/22/2016	0.34	0.18	0.37	1.5	41.9	0.97	
		8/25/2016	0.18	0.17	0.77	0.37	20.8	2.3	
Iron, Dissolved	ug/L	5/26/2016	2100	8550	870	2600	57.9	2700	50.0
		6/24/2016	14000	6240	12700	3620	176	4800	
		7/22/2016	13200	989	3350	855	73.8	1360	
		8/25/2016	15600	729	4110	4840	124	377	
Sulfate	mg/L	5/26/2016	39.7	105	18.2	81.3	82.8	3.0	2.0
		6/24/2016	2.3	16.1	<2.0	2.0	24.3	14.1	
		7/22/2016	2.1	27.3	2.1	3.0	17.0	2.6	
		8/25/2016	<2.0	<2.0	<2.0	<2.0	8.2	<2.0	
Chloride	mg/L	5/26/2016	23.1	21.0	39.3	31.6	26.2	12.0	1.0
		6/24/2016	32.6	29.0	37.3	40.6	52.9	18.6	
		7/22/2016	33.0	31.3	40.7	43.7	40.4	15.3	
		8/25/2016	19.1	24.4	41.5	44.7	47.4	20.7	
Sodium, Dissolved	ug/L	5/26/2016	13100	12600	20000	21400	15400	9010	1000
		6/24/2016	20200	16800	18400	21800	29400	11400	
		7/22/2016	18800	16500	19300	24000	24500	10600	
		8/25/2016	13600	14400	24800	27600	34400	16700	
Calcium, Dissolved	ug/L	5/26/2016	28800	31800	34400	46900	49200	18400	500
		6/24/2016	50600	25900	37500	33200	53700	22900	
		7/22/2016	50400	30100	45200	37600	73700	25200	
		8/25/2016	40100	26600	45500	40100	82700	36700	
Potassium, Dissolved	ug/L	5/26/2016	4530	4260	5770	7590	3460	3190	2500
		6/24/2016	7130	5290	5550	7150	5450	4080	
		7/22/2016	6950	4920	5460	7530	6750	4010	
		8/25/2016	8910	4720	7810	8800	8800	4970	
Magnesium, Dissolved	ug/L	5/26/2016	28700	35400	30400	53700	42300	19600	500
		6/24/2016	49100	25200	23000	31900	63300	23200	
		7/22/2016	46200	30100	29800	38700	69500	25600	
		8/25/2016	34800	28000	39400	38400	93900	42700	
Manganese, Dissolved	ug/L	5/26/2016	604	720	302	633	63.9	231	5.0
		6/24/2016	1270	1370	720	502	257	355	
		7/22/2016	958	287	522	366	341	247	
		8/25/2016	1260	376	604	664	121	281	

MDL - Minimum Detection Limit

Vaires - MDL changes based on result's concentration.







Appendix C

Twin Lakes 2016 Inflow / Outflow Water Sampling Data

TWIN LAKES
INFLOW / OUTFLOW SAMPLING EVENT
5/26/2016

Analytes - Cations	Little Sandy Inflow 1	Little Sandy Inflow 2	Little Sandy Inflow 3	Little Sandy Middle	Sandy Middle	Twin Lakes Outflow	Culvert Inflow	Reporting Detection Limits	Reporting Units
Aluminum	**55.8**	<0.50	<0.50	NM	NM	<0.50	<0.50	**0.50**	ug / L
Arsenic	NM	NM	NM	NM	NM	NM	NM	**0.05**	ug / L
Barium	NM	NM	NM	NM	NM	NM	NM	**10.0**	ug / L
Calcium	**64.7**	**30.7**	**34.5**	**28.2**	**38.3**	**24.3**	**11.3**	**0.50**	mg / L
Iron	**1270**	**531**	**381**	NM	NM	**502**	**1560**	**50.0**	ug / L
Magnesium	**86.4**	**41.9**	**47.5**	**38.3**	**51.3**	**31.2**	**4.1**	**0.50**	mg / L
Manganese	**183**	**51.9**	**77.2**	NM	NM	**46.8**	**62.9**	**10.0**	ug / L
Phosphorus	NM	NM	NM	NM	NM	NM	NM	**0.10**	mg / L
Potassium	**9.5**	**4.6**	**4.3**	**4.0**	**5.2**	**3.5**	**1.6**	**0.50**	mg / L
Rubidium	NM	NM	NM	NM	NM	NM	NM	**1.0**	ug / L
Sodium	**34.8**	**14.3**	**14.8**	**13.5**	**17.5**	**11.5**	**4.1**	**0.50**	mg / L
Strontium	NM	NM	NM	NM	NM	NM	NM	**10.0**	ug / L
Analytes - Anions	==========	==========	==========	==========	==========	==========	==========	==========	==========
Chloride	**51.8**	**20.5**	**21.7**	**19.8**	**26.4**	**16.4**	**9.4**	**1.0**	mg / l
Nitrogen, Kjeldahl, Total	**0.68**	**0.96**	**0.92**	**0.80**	**0.76**	**0.71**	<0.50	**0.50**	mg / L
Ammonium as Nitrogen	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	**0.10**	mg / L
Sulfate	**338**	**216**	**156**	**129**	**183**	**92.7**	<2.0	**2.0**	mg / L
Analytes - Other	==========	==========	==========	==========	==========	==========	==========	==========	==========
Total Dissolved Solids	**761**	**407**	**417**	**363**	**438**	**295**	**141**	**10.0**	mg / L
Total Suspended Solids	**4.0**	**18.7**	**6.5**	**2.0**	**2.8**	**1.6**	**2.4**	**1.0**	mg / L
Alkalinity, Total as CaCO3	**174**	**120**	**140**	**106**	**138**	**92.4**	**37.1**	**6.1**	mg / L
Dissolved Organic Carbon	**10.5**	**15.6**	**16.2**	NM	NM	**14.8**	**13.9**	**1.0**	mg / L
Total Hardness by 2340B	**517**	**249**	**282**	**228**	**307**	**189**	**45.1**	**3.3**	mg / L
UV Absorbance @ 254 nm	NM	NM	NM	NM	NM	NM	NM	**0.009**	cm^{-1}
SUVA	NM	NM	NM	NM	NM	NM	NM	**0.1**	L / mg*m
YSI Probe Plus Data	==========	==========	==========	==========	==========	==========	==========	==========	==========
pH	**7.3**	**7.3**	**7.2**	**8.2**	**8.1**	**7.6**	**7.0**	**± 0.2**	Units
Temperature	**15.0**	**16.6**	**15.3**	**18.2**	**17.6**	**16.2**	**14.2**	**± 0.1**	°C
Specific Conductance	**1109**	**574**	**560**	**682**	**517**	**359**	**112**	**± 1%**	uS / cm
Dissolved Oxygen	NM	NM	NM	NM	NM	NM	NM	**± 0.01**	mg / L

Bold Print indicates the sample is above the detection limit
"<" indicates value below reporting limit
NM indicates that the analyte was not measured

TWIN LAKES
INFLOW / OUTFLOW SAMPLING EVENT
6/24/2016

Analytes - Cations	**Little Sandy Inflow 1**	**Little Sandy Inflow 2**	**Little Sandy Inflow 3**	**Little Sandy Middle**	**Sandy Middle**	**Twin Lakes Outflow**	**Culvert Inflow**	**Reporting Detection Limits**	**Reporting Units**
Aluminum	<50.0	<200	<200	NM	NM	<200	<200	**200**	ug / L
Arsenic	NM	NM	NM	NM	NM	NM	NM	**0.05**	ug / L
Barium	NM	NM	NM	NM	NM	NM	NM	**10.0**	ug / L
Calcium	**43.6**	**34.0**	**34.4**	**35.5**	**31.5**	**25.2**	**11.8**	**0.50**	mg / L
Iron	**2590**	**929**	**439**	NM	NM	**724**	**5360**	**50.0**	ug / L
Magnesium	**54.5**	**47.5**	**49.0**	**48.9**	**42.9**	**33.4**	**3.9**	**0.50**	mg / L
Manganese	**81.3**	**101**	**82.8**	NM	NM	**70.6**	**411**	**5.0**	ug / L
Phosphorus	NM	NM	NM	NM	NM	NM	NM	**0.10**	mg / L
Potassium	**4.9**	**3.5**	**3.2**	**3.7**	**3.6**	**3.1**	<2.5	**2.50**	mg / L
Rubidium	NM	NM	NM	NM	NM	NM	NM	**1.0**	ug / L
Sodium	**22.5**	**14.9**	**14.6**	**15.9**	**15.2**	**12.4**	**3.1**	**1.0**	mg / L
Strontium	NM	NM	NM	NM	NM	NM	NM	**10.0**	ug / L
Analytes - Anions	==========	==========	==========	==========	==========	==========	==========	==========	==========
Chloride	**31.8**	21.0	**20.6**	**23.0**	**22.0**	**19.5**	**7.1**	**2.0**	mg / L
Nitrogen, Kjeldahl, Total	**0.73**	0.70	**0.60**	<0.50	<0.50	<0.50	**0.67**	**0.50**	mg / L
Ammonium as Nitrogen	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	**0.10**	mg / L
Sulfate	**212**	160	**163**	**170**	**147**	**114**	<2.0	**4.0**	mg / L
Analytes - Other	==========	==========	==========	==========	==========	==========	==========	==========	==========
Total Dissolved Solids	**530**	**447**	**447**	**465**	**389**	**316**	**145**	**10.0**	mg / L
Total Suspended Solids	**1.5**	**3.5**	**2.8**	**3.2**	**1.2**	**2.0**	**10**	**1.0**	mg / L
Alkalinity, Total as CaCO3	**149**	**152**	**163**	**149**	**127**	**105**	**40.8**	**6.1**	mg / L
Dissolved Organic Carbon	**23.4**	**26.1**	**21.5**	NM	NM	**18.3**	**25.7**	**1.0**	mg / L
Total Hardness by 2340B	**333**	**281**	**287**	**290**	**255**	201	**45.6**	**3.3**	mg / L
UV Absorbance @ 254 nm	NM	NM	NM	NM	NM	NM	NM	**0.009**	cm^{-1}
SUVA	NM	NM	NM	NM	NM	NM	NM	**0.1**	L / mg*m
YSI Data	==========	==========	==========	==========	==========	==========	==========	==========	==========
pH	**7.0**	**7.1**	**7.2**	**7.7**	**7.7**	**7.4**	**6.5**	**± 0.2**	Units
Temperature	**19.1**	**22.5**	**20.3**	**22.8**	**22.3**	**21.3**	**19.8**	**± 0.1**	°C
Specific Conductance	**743**	**606**	**644**	**637**	**540**	**445**	**102**	**± 1%**	uS / cm
Dissolved Oxygen	NM	NM	NM	NM	NM	NM	NM	**± 0.01**	mg / L

Bold Print indicates the sample is above the detection limit
"<" indicates value below reporting limit
NM indicates that the analyte was not measured

TWIN LAKES
INFLOW / OUTFLOW SAMPLING EVENT
7/22/2016

Analytes - Cations	**Little Sandy Inflow 1**	**Little Sandy Inflow 2**	**Little Sandy Inflow 3**	**Little Sandy Middle**	**Sandy Middle**	**Twin Lakes Outflow**	**Culvert Inflow**	**Detection Limits**	**Reporting Units**
Aluminum	284	55.0	69.1	NM	NM	51.0	107	50.0	ug / L
Arsenic	NM	NM	NM	NM	NM	NM	NM	0.50	ug / L
Barium	NM	NM	NM	NM	NM	NM	NM	10.0	ug / L
Calcium	39.4	36.1	36.6	30.1	36.5	27.4	14.1	0.50	mg / L
Iron	20700	2320	3270	NM	NM	2510	10400	50.0	ug / L
Magnesium	45.6	48.7	49.2	39.7	49.1	35.3	4.7	0.50	mg / L
Manganese	429	179	197	NM	NM	138	419	10.0	ug / L
Phosphorus	NM	NM	NM	NM	NM	NM	NM	0.10	mg / L
Potassium	2.6	2.9	2.9	2.9	3.0	2.8	0.94	0.50	mg / L
Rubidium	NM	NM	NM	NM	NM	NM	NM	1.0	ug / L
Sodium	17.1	15.1	15.1	13.8	15.6	12.6	3.4	0.50	mg / L
Strontium	NM	NM	NM	NM	NM	NM	NM	10.0	ug / L
Analytes - Anions	==========	==========	==========	==========	==========	==========	==========	==========	==========
Chloride	20.9	17.9	17.6	17.8	18.4	16.8	7.5	1.0/2.0	mg / l
Nitrogen, Kjeldahl, Total	2.6	1.5	1.6	1.4	1.3	1.3	1.3	0.50	mg / L
Ammonium as Nitrogen	0.36	0.15	0.12	0.15	0.11	0.13	0.12	0.10	mg / L
Sulfate	120	121	121	104	125	92.1	2.3	2.0/8.0	mg / L
Analytes - Other	==========	==========	==========	==========	==========	==========	==========	==========	==========
Total Dissolved Solids	431	409	372	378	398	276	126	10.0	mg / L
Total Suspended Solids	14.0	<2.5	<2.5	2.0	<1.0	3.6	5.0	1.0/2.5	mg / L
Alkalinity, Total as CaCO3	153	175	179	114	160	125	40.2	6.1/5.0	mg / L
Dissolved Organic Carbon	63.7	36.1	38.2	NM	NM	31.6	35.4	1.0	mg / L
Total Hardness by 2340B	286	291	294	239	293	214	54.5	3.3	mg / L
UV Absorbance @ 254 nm	NM	NM	NM	NM	NM	NM	NM	0.009	cm^{-1}
SUVA	NM	NM	NM	NM	NM	NM	NM	0.1	L / mg*m
YSI Data	==========	==========	==========	==========	==========	==========	==========	==========	==========
pH	6.7	6.9	7.3	7.3	7.3	7.3	6.5	± 0.2	Units
Temperature	21.4	24.2	23.6	25.1	24.8	25.0	19.2	± 0.1	°C
Specific Conductance	547	572	585	567	459	422	107	± 1%	uS / cm
Dissolved Oxygen	NM	NM	NM	NM	NM	NM	NM	± 0.01	mg / L

Bold Print indicates the sample is above the detection limit
"<" indicates value below reporting limit
NM indicates that the analyte was not measured

TWIN LAKES
INFLOW / OUTFLOW SAMPLING EVENT
8/25/2016

Analytes - Cations	**Little Sandy Inflow 1**	**Little Sandy Inflow 2**	**Little Sandy Inflow 3**	**Little Sandy Middle**	**Sandy Middle**	**Twin Lakes Outflow**	**Culvert Inflow**	**Reporting Detection Limits**	**Reporting Units**
Aluminum	**70.5**	**111**	<50.0	NM	NM	**57.3**	**132**	**50.0**	ug / L
Arsenic	NM	NM	NM	NM	NM	NM	NM	**0.50**	ug / L
Barium	NM	NM	NM	NM	NM	NM	NM	**10.0**	ug / L
Calcium	**69.6**	**38.6**	**40.0**	NM	NM	**28.0**	**14.2**	**0.50**	mg / L
Iron	**2090**	**2250**	**1650**	NM	NM	**3280**	**10700**	**50.0**	ug / L
Magnesium	**99.3**	**53.5**	**56.0**	NM	NM	**33.4**	**4.9**	**0.50**	mg / L
Manganese	**138**	**214**	**220**	NM	NM	**136**	**304**	**10.0**	ug / L
Phosphorus	NM	NM	NM	NM	NM	NM	NM	**0.10**	mg / L
Potassium	**5.5**	**2.3**	**2.5**	NM	NM	**2.2**	**1.1**	**0.50**	mg / L
Rubidium	NM	NM	NM	NM	NM	NM	NM	**1.0**	ug / L
Sodium	**39.0**	**15.4**	**16.8**	NM	NM	**11.7**	**4.1**	**0.50**	mg / L
Strontium	NM	NM	NM	NM	NM	NM	NM	**10.0**	ug / L
Analytes - Anions	==========	==========	==========	==========	==========	==========	==========	==========	==========
Chloride	**56.5**	**18.6**	**20.2**	NM	NM	**15.4**	**9.5**	**1.0/2.0**	mg / l
Nitrogen, Kjeldahl, Total	**0.87**	**2.1**	**1.3**	NM	NM	**1.5**	**0.99**	**0.60**	mg / L
Ammonium as Nitrogen	<0.10	**0.29**	**0.16**	NM	NM	**0.32**	<0.10	**0.10**	mg / L
Sulfate	**314**	**96.7**	**108**	NM	NM	**64.3**	<2.0	**2.0/4.0**	mg / L
Analytes - Other	==========	==========	==========	==========	==========	==========	==========	==========	==========
Total Dissolved Solids	**836**	**434**	**473**	NM	NM	**356**	**155**	**10.0**	mg / L
Total Suspended Solids	**2.8**	**22.0**	**5.2**	NM	NM	<1.0	**26.0**	**1.0/1.7**	mg / L
Alkalinity, Total as CaCO3	**278**	**240**	**237**	NM	NM	**152**	**48.4**	**6.1**	mg / L
Dissolved Organic Carbon	**22.1**	**38.9**	**37.1**	NM	NM	**39.1**	**26.9**	**1.0/2.0**	mg / L
Total Hardness by 2340B	**582**	**317**	**330**	NM	NM	**207**	**55.5**	**3.3**	mg / L
UV Absorbance @ 254 nm	NM	NM	NM	NM	NM	NM	NM	**0.009**	cm^{-1}
SUVA	NM	NM	NM	NM	NM	NM	NM	**0.1**	L / mg*m
YSI Data	==========	==========	==========	==========	==========	==========	==========	==========	==========
pH	7.1	**7.4**	**7.2**	NM	NM	**7.3**	**6.7**	**± 0.2**	Units
Temperature	**19.1**	**20.2**	**19.8**	NM	NM	**20.0**	**16.1**	**± 0.1**	°C
Specific Conductance	**1141**	**600**	**576**	NM	NM	**417**	**119**	**± 1%**	uS / cm
Dissolved Oxygen	NM	NM	NM	NM	NM	NM	NM	**± 0.01**	mg / L

Bold Print indicates the sample is above the detection limit
"<" indicates value below reporting limit
NM indicates that the analyte was not measured

TWIN LAKES
INFLOW / OUTFLOW SAMPLING EVENT
9/28/2016

Analytes - Cations	**Little Sandy Inflow 1**	**Little Sandy Inflow 2**	**Little Sandy Inflow 3**	**Little Sandy Middle**	**Sandy Middle**	**Twin Lakes Outflow**	**Culvert Inflow**	**Reporting Detection Limits**	**Reporting Units**
Aluminum	**84.6**	<50.0	<50.0	NM	NM	<50.0	**54.5**	**50.0**	ug / L
Arsenic	NM	NM	NM	NM	NM	NM	NM	**0.50**	ug / L
Barium	NM	NM	NM	NM	NM	NM	NM	**10.0**	ug / L
Calcium	**54.4**	**47.4**	**30.9**	NM	NM	**28.6**	**10.4**	**0.50**	mg / L
Iron	**1150**	**455**	**353**	NM	NM	**1420**	**2750**	**50.0**	ug / L
Magnesium	**72.6**	**65.9**	**49.4**	NM	NM	**36.0**	**3.7**	**0.50**	mg / L
Manganese	**84.7**	**84.0**	**90.6**	NM	NM	**54.1**	**101**	**10.0**	ug / L
Phosphorus	NM	NM	NM	NM	NM	NM	NM	**0.10**	mg / L
Potassium	**5.8**	**3.3**	**1.5**	NM	NM	**2.6**	**1.5**	**0.50**	mg / L
Rubidium	NM	NM	NM	NM	NM	NM	NM	**1.0**	ug / L
Sodium	**28.4**	**20.9**	**9.2**	NM	NM	**13.3**	**4.0**	**0.50**	mg / L
Strontium	NM	NM	NM	NM	NM	NM	NM	**10.0**	ug / L
Analytes - Anions	==========	==========	==========	==========	==========	==========	==========	==========	==========
Chloride	**47.0**	**31.5**	**12.5**	NM	NM	**21.1**	**10.4**	**1.0/2.0**	mg / l
Nitrogen, Kjeldahl, Total	**0.71**	**0.88**	**0.85**	NM	NM	**0.94**	<0.60	**0.60**	mg / L
Ammonium as Nitrogen	<0.10	<0.10	<0.10	NM	NM	**0.11**	<0.10	**0.10**	mg / L
Sulfate	**229**	**165**	**39.6**	NM	NM	**81.9**	<2.0	**2.0/4.0**	mg / L
Analytes - Other	==========	==========	==========	==========	==========	==========	==========	==========	==========
Total Dissolved Solids	**661**	**561**	**367**	NM	NM	**346**	**120**	**10.0**	mg / L
Total Suspended Solids	**3.2**	**3.6**	**2.4**	NM	NM	**2.4**	**3.5**	**1.0**	mg / L
Alkalinity, Total as CaCO3	**207**	**251**	**255**	NM	NM	**145**	**34.8**	**6.1**	mg / L
Dissolved Organic Carbon	**19.5**	**27.7**	**32.2**	NM	NM	**27.9**	**16.9**	**1.0/5.0**	mg / L
Total Hardness by 2340B	**435**	**390**	**280**	NM	NM	**220**	**41.2**	**3.3**	mg / L
UV Absorbance @ 254 nm	NM	NM	NM	NM	NM	NM	NM	**0.009**	cm^{-1}
SUVA	NM	NM	NM	NM	NM	NM	NM	**0.1**	L / mg*m
YSI Data	==========	==========	==========	==========	==========	==========	==========	==========	==========
pH	**7.3**	**7.8**	**7.4**	NM	NM	**7.6**	**6.8**	**± 0.2**	Units
Temperature	**10.9**	**11.7**	**11.8**	NM	NM	**11.0**	**11.2**	**± 0.1**	°C
Specific Conductance	**895**	**781**	**517**	NM	NM	**462**	**102.6**	**± 1%**	uS / cm
Dissolved Oxygen	NM	NM	NM	NM	NM	NM	NM	**± 0.01**	mg / L

Bold Print indicates the sample is above the detection limit
"<" indicates value below reporting limit
NM indicates that the analyte was not measured

TWIN LAKES
INFLOW / OUTFLOW SAMPLING EVENT

10/20/2016

Analytes - Cations	Little Sandy Inflow 1	Little Sandy Inflow 2	Little Sandy Inflow 3	Little Sandy Middle	Sandy Middle	Twin Lakes Outflow	Culvert Inflow	Reporting Detection Limits	Reporting Units
Aluminum	**83.1**	<50.0	<50.0	<50.0	<50.0	<50.0	<50.0	**50.0**	ug / L
Arsenic	NM	NM	NM	NM	NM	NM	NM	**0.50**	ug / L
Barium	NM	NM	NM	NM	NM	NM	NM	**10.0**	ug / L
Calcium	**63.7**	**47.2**	**30.1**	**46.0**	**38.7**	**33.4**	**10.0**	**0.50**	mg / L
Iron	**1250**	**442**	**268**	**388**	**650**	**880**	**2220**	**50.0**	ug / L
Magnesium	**92.4**	**69.1**	**54.2**	**67.2**	**55.6**	**46.5**	**3.8**	**0.50**	mg / L
Manganese	**143**	**96.1**	**94.1**	**63.3**	**38.4**	**68.1**	**98.7**	**10.0**	ug / L
Phosphorus	NM	NM	NM	NM	NM	NM	NM	**0.10**	mg / L
Potassium	**7.7**	**3.9**	**1.5**	**4.1**	**3.6**	**3.1**	**1.6**	**0.50**	mg / L
Rubidium	NM	NM	NM	NM	NM	NM	NM	**1.0**	ug / L
Sodium	**35.7**	**23.0**	**10.6**	**23.0**	**20.1**	**17.1**	**4.2**	**0.50**	mg / L
Strontium	NM	NM	NM	NM	NM	NM	NM	**10.0**	ug / L
Analytes - Anions	==========	==========	==========	==========	==========	==========	==========	==========	==========
Chloride	**53.6**	**33.7**	**15.1**	**34.7**	**30.2**	**26.1**	**10.6**	**1.0/5.0**	mg / l
Nitrogen, Kjeldahl, Total	<0.60	**0.80**	**0.66**	**0.75**	**0.79**	**0.79**	<0.60	**0.60**	mg / L
Ammonium as Nitrogen	<0.10	<0.10	<0.10	<0.10	<.010	<0.10	<0.10	**0.10**	mg / L
Sulfate	**294**	**172**	**84.3**	**176**	**135**	**109**	<2.0	**2.0/10.0**	mg / L
Analytes - Other	==========	==========	==========	==========	==========	==========	==========	==========	==========
Total Dissolved Solids	**739**	**532**	**375**	**548**	**460**	**392**	**113**	**10.0**	mg / L
Total Suspended Solids	**2.4**	**4.4**	**2.0**	**2.4**	**1.6**	**2.0**	**3.2**	**1.0**	mg / L
Alkalinity, Total as CaCO3	**215**	**216**	**213**	**222**	**179**	**147**	**36.6**	**6.1**	mg / L
Dissolved Organic Carbon	**15.0**	**22.3**	**24.0**	**21.6**	**25.1**	**23.8**	**11.7**	**1.0**	mg / L
Total Hardness by 2340B	**540**	**402**	**298**	**392**	**326**	**275**	**40.4**	**3.3**	mg / L
UV Absorbance @ 254 nm	NM	NM	NM	NM	NM	NM	NM	**0.009**	cm^{-1}
SUVA	NM	NM	NM	NM	NM	NM	NM	**0.1**	L / mg*m
YSI Data	==========	==========	==========	==========	==========	==========	==========	==========	==========
pH	**7.1**	**6.9**	**7.2**	**8.0**	**8.0**	**7.6**	**7.0**	**± 0.2**	Units
Temperature	**5.8**	**6.0**	**5.4**	**7.6**	**7.3**	**6.5**	**5.8**	**± 0.1**	°C
Specific Conductance	**1057**	**632**	**526**	**732**	**619**	**527**	**105**	**± 1%**	uS / cm
Dissolved Oxygen	NM	NM	NM	NM	NM	NM	NM	**± 0.01**	mg / L

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LITTLE SANDY LAKE - INFLOW 1

Analytes - Cations	5/26/2016 Little Sandy Inflow 1	6/24/2016 Little Sandy Inflow 1	7/22/2016 Little Sandy Inflow 1	8/25/2016 Little Sandy Inflow 1	9/28/2016 Little Sandy Inflow 1	10/20/2016 Little Sandy Inflow 1	Reporting Units
Aluminum	**55.8**	<50.0	**284**	**70.5**	**84.6**	**83.1**	µg / L
Arsenic	NM	NM	NM	NM	NM	NM	µg / L
Barium	NM	NM	NM	NM	NM	NM	µg / L
Calcium	**64.7**	**43.6**	**39.4**	**69.6**	**54.4**	**63.7**	mg / L
Iron	**1270**	**2590**	**20700**	**2090**	**1150**	**1250**	µg / L
Magnesium	**86.4**	**54.5**	**45.6**	**99.3**	**72.6**	**92.4**	mg / L
Manganese	**183**	**81.3**	**429**	**138**	**84.7**	**143**	µg / L
Phosphorus	NM	NM	NM	NM	NM	NM	mg / L
Potassium	**9.5**	**4.9**	**2.6**	**5.5**	**5.8**	**7.7**	mg / L
Rubidium	NM	NM	NM	NM	NM	NM	µg / L
Sodium	**34.8**	**22.5**	**17.1**	**39**	**28.4**	**35.7**	mg / L
Strontium	NM	NM	NM	NM	NM	NM	µg / L
Analytes - Anions	==========	==========	==========	==========	==========	==========	==========
Chloride	**51.8**	**31.8**	**20.9**	**56.5**	**47**	**53.6**	mg / L
Nitrogen, Kjeldahl, Total	**0.68**	**0.73**	**2.6**	**0.87**	**0.71**	<0.60	mg / L
Ammonium as Nitrogen	NM	<0.10	**0.36**	<0.10	<0.10	<0.10	mg / L
Sulfate	**338**	**212**	**120**	**314**	**229**	**294**	mg / L
Analytes - Other	==========	==========	==========	==========	==========	==========	==========
Total Dissolved Solids	**761**	**530**	**431**	**836**	**661**	**739**	mg / L
Total Suspended Solids	**4.0**	**1.5**	**14**	2.8	**3.2**	**2.4**	mg / L
Alkalinity, Total as CaCO3	**174**	**149**	**153**	**278**	**207**	**215**	mg / L
Dissolved Organic Carbon	**10.5**	**23.4**	**63.7**	**22.1**	**19.5**	**15**	mg / L
Total Hardness by 2340B	**517**	**333**	**286**	**582**	**435**	**540**	mg / L
UV Absorbance @ 254 nm	NM	NM	NM	NM	NM	NM	cm^{-1}
SUVA	NM	NM	NM	NM	NM	NM	L / mg*m
YSI Probe Plus Data	==========	==========	==========	==========	==========	==========	==========
pH	**7.3**	**6.99**	**6.7**	**7.13**	**7.25**	**7.13**	Units
Temperature	**15.0**	**19.1**	**21.4**	**19.1**	**10.9**	**5.8**	°C
Specific Conductance	**1109**	**743**	**547.0**	**1141**	**895**	**1057**	uS / cm
Dissolved Oxygen	NM	NM	NM	NM	NM	NM	mg / L

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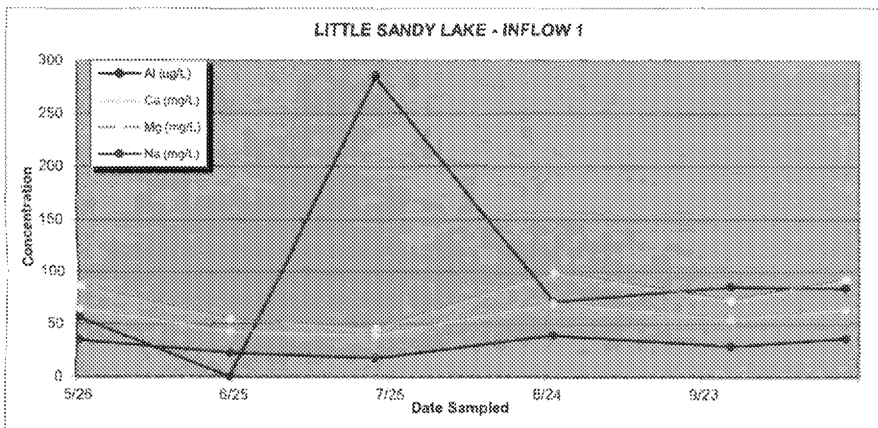

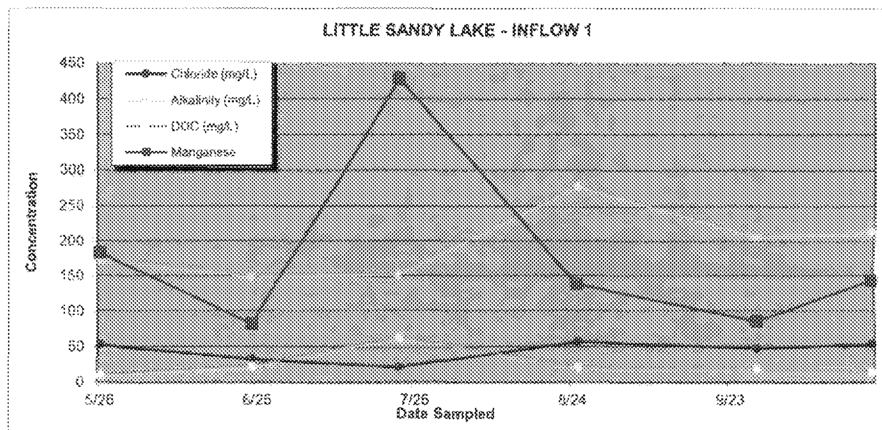

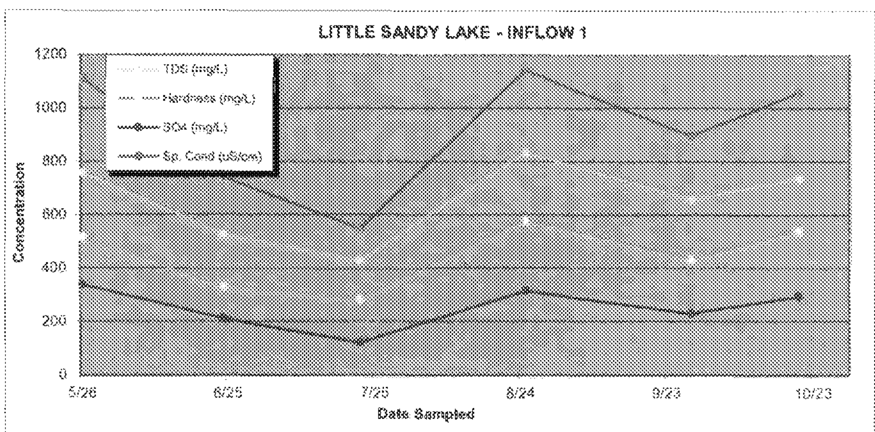

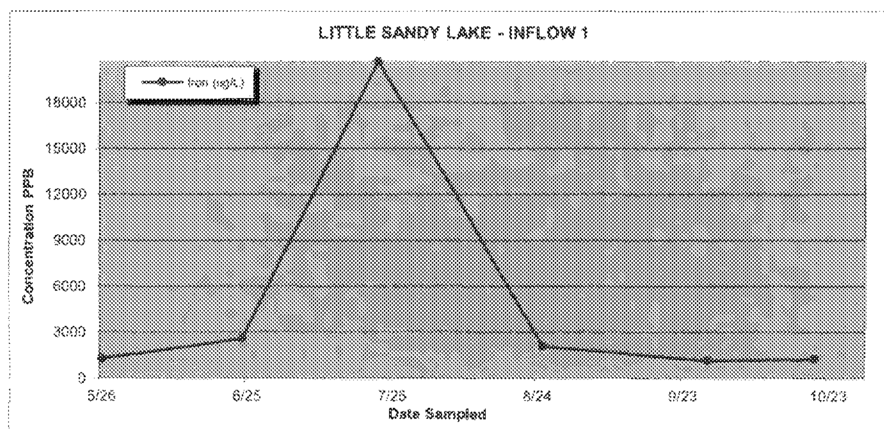

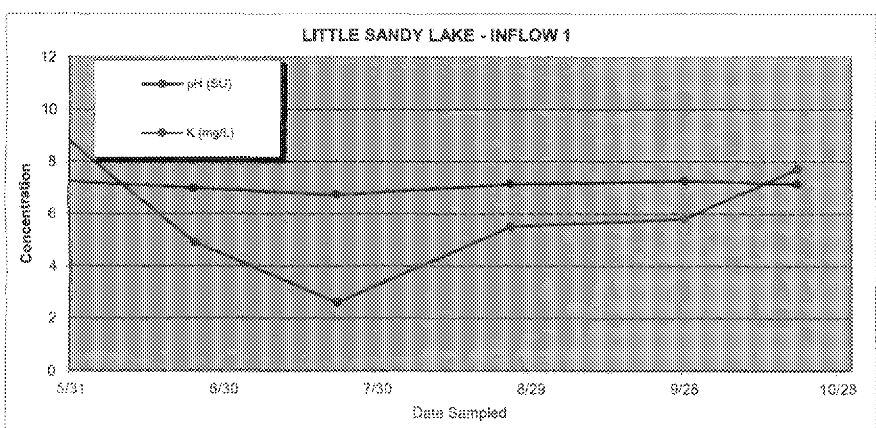

LITTLE SANDY LAKE - INFLOW 2

Analytes - Cations	5/26/2016 Little Sandy Inflow 2	6/24/2016 Little Sandy Inflow 2	7/22/2016 Little Sandy Inflow 2	8/25/2016 Little Sandy Inflow 2	9/28/2016 Little Sandy Inflow 2	10/20/2016 Little Sandy Inflow 2	Reporting Units
Aluminum	<0.50	<200	**55**	**111**	<50.0	<50.0	µg / L
Arsenic	NM	NM	NM	NM	NM	NM	µg / L
Barium	NM	NM	NM	NM	NM	NM	µg / L
Calcium	**30.7**	**34.0**	**36.1**	**38.6**	**47.4**	**47.2**	mg / L
Iron	**531**	**929**	**2320**	**2250**	**455**	**442**	µg / L
Magnesium	**41.9**	**47.5**	**48.7**	**53.5**	**65.9**	**69.1**	mg / L
Manganese	**51.9**	**101**	**179**	**214**	**84.0**	**96.1**	µg / L
Phosphorus	NM	NM	NM	NM	NM	NM	mg / L
Potassium	**4.6**	**3.5**	**2.9**	**2.3**	**3.3**	**3.91**	mg / L
Rubidium	NM	NM	NM	NM	NM	NM	µg / L
Sodium	**14.3**	**14.9**	**15.1**	**15.4**	**20.9**	**23.0**	mg / L
Strontium	NM	NM	NM	NM	NM	NM	µg / L
Analytes - Anions	==========	==========	==========	==========	==========	==========	==========
Chloride	**20.5**	**21**	**17.9**	**18.6**	**31.5**	**33.7**	mg / L
Nitrogen, Kjeldahl, Total	**0.96**	**0.7**	**1.5**	**2.1**	**0.88**	**0.8**	mg / L
Ammonium as Nitrogen	NM	<0.10	**0.15**	**0.29**	<0.10	<0.10	mg / L
Sulfate	**216**	**160**	**121**	**96.7**	**165**	**172**	mg / L
Analytes - Other	==========	==========	==========	==========	==========	==========	==========
Total Dissolved Solids	**407**	**447**	**409**	**434**	**561**	**532**	mg / L
Total Suspended Solids	NM	NM	<2.5	**22.0**	**3.6**	**4.4**	mg / L
Alkalinity, Total as CaCO3	**120**	**152**	**175**	**240**	**251**	**216**	mg / L
Dissolved Organic Carbon	**15.6**	**26.1**	**36.1**	**38.9**	**27.7**	**22.3**	mg / L
Total Hardness by 2340B	**249**	**281**	**291**	**317**	**390**	**402**	mg / L
UV Absorbance @ 254 nm	NM	NM	NM	NM	NM	NM	cm^{-1}
SUVA	NM	NM	NM	NM	NM	NM	L / mg*m
YSI Probe Plus Data	==========	==========	==========	==========	==========	==========	==========
pH	**7.3**	**7.1**	**6.9**	**7.4**	**7.8**	**6.9**	Units
Temperature	**16.6**	**22.5**	**24.2**	**20.2**	**11.7**	**6**	°C
Specific Conductance	**574**	**606**	**572**	**600**	**781**	**632**	uS / cm
Dissolved Oxygen	NM	NM	NM	NM	NM	NM	mg / L

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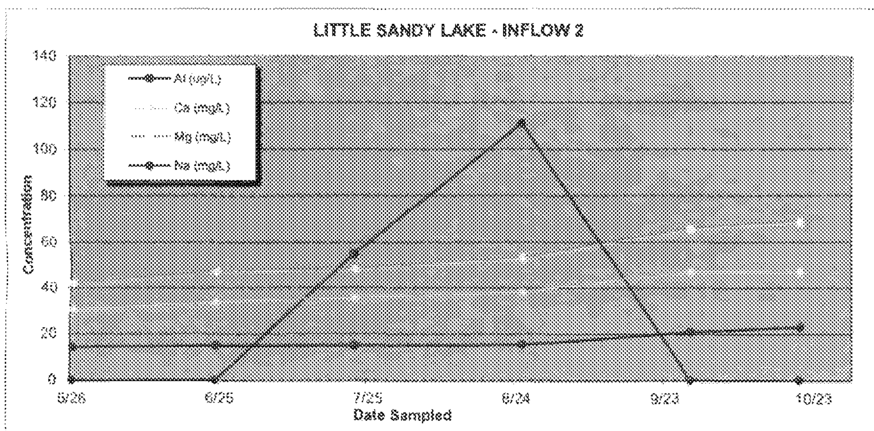

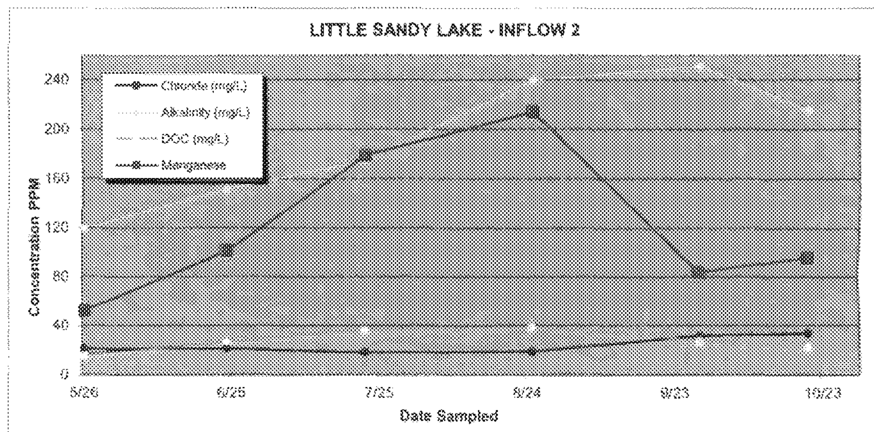

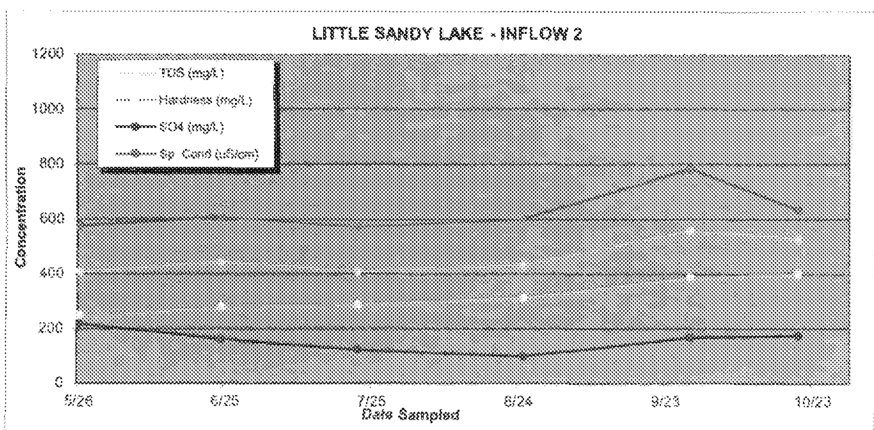

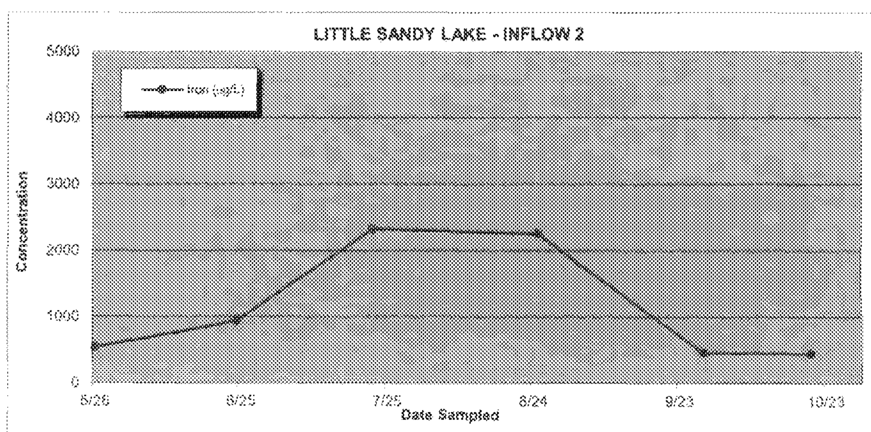

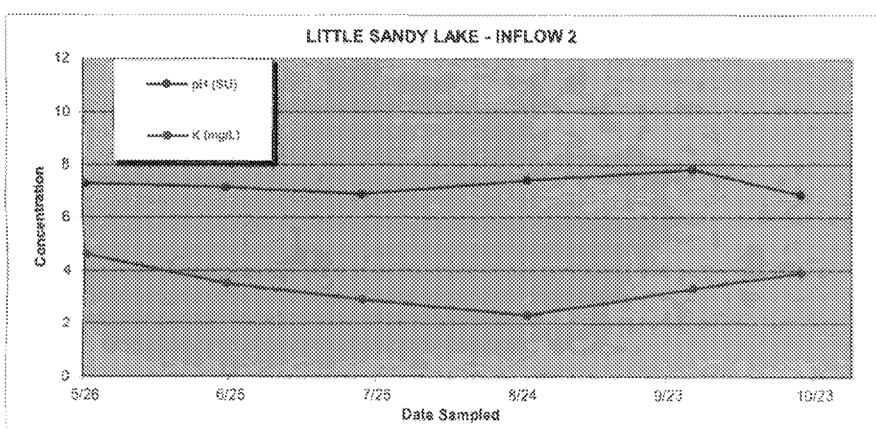

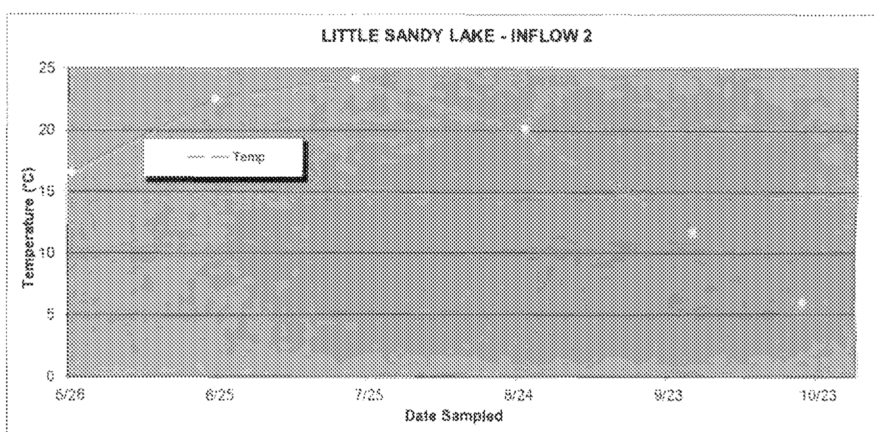

LITTLE SANDY LAKE - INFLOW 3

Analytes - Cations	5/26/2016 Little Sandy Inflow 3	6/24/2016 Little Sandy Inflow 3	7/22/2016 Little Sandy Inflow 3	8/25/2016 Little Sandy Inflow 3	9/28/2016 Little Sandy Inflow 3	10/20/2016 Little Sandy Inflow 3	Reporting Units
Aluminum	<0.50	<200	**69.1**	<50.0	<50.0	<50.0	µg / L
Arsenic	NM	NM	NM	NM	NM	NM	µg / L
Barium	NM	NM	NM	NM	NM	NM	µg / L
Calcium	**34.5**	**34.4**	**36.6**	**40.0**	**30.9**	**30.1**	mg / L
Iron	**381**	**439**	**3270**	**1650**	**353**	**268**	µg / L
Magnesium	**47.5**	**49.0**	**49.2**	**56.0**	**49.4**	**54.2**	mg / L
Manganese	**77.2**	**82.8**	**197**	**220**	**90.6**	**94.1**	µg / L
Phosphorus	NM	NM	NM	NM	NM	NM	mg / L
Potassium	**4.3**	**3.2**	**2.9**	**2.5**	**1.5**	**1.5**	mg / L
Rubidium	NM	NM	NM	NM	NM	NM	µg / L
Sodium	**14.8**	**14.6**	**15.1**	**16.8**	**9.2**	**10.6**	mg / L
Strontium	NM	NM	NM	NM	NM	NM	µg / L
Analytes - Anions	==========	==========	==========	==========	==========	==========	==========
Chloride	**21.7**	**20.6**	**17.6**	**20.2**	**12.5**	**15.1**	mg / L
Nitrogen, Kjeldahl, Total	**0.92**	**0.60**	**1.6**	**1.3**	**0.85**	**0.66**	mg / L
Ammonium as Nitrogen	NM	<0.10	**0.12**	**0.16**	<0.10	<0.10	*mg / L*
Sulfate	**156**	**163**	**121**	**108**	**39.6**	**84.3**	mg / L
Analytes - Other	==========	==========	==========	==========	==========	==========	==========
Total Dissolved Solids	**417**	**447**	**372**	**473**	**367**	**375**	mg / L
Total Suspended Solids	**6.5**	**2.8**	<2.5	**5.2**	**2.4**	**2.0**	mg / L
Alkalinity, Total as CaCO3	**140**	**163**	**179**	**237**	**255**	**213**	mg / L
Dissolved Organic Carbon	**16.2**	**21.5**	**38.2**	**37.1**	**32.2**	**24.0**	mg / L
Total Hardness by 2340B	**282**	**287**	**294**	**330**	**280**	**298**	mg / L
UV Absorbance @ 254 nm	NM	NM	NM	NM	NM	NM	cm^{-1}
SUVA	NM	NM	NM	NM	NM	NM	L / mg*m
YSI Probe Plus Data	==========	==========	==========	==========	==========	==========	==========
pH	**7.2**	**7.2**	**7.3**	**7.2**	**7.4**	**7.2**	Units
Temperature	**15.3**	**20.3**	**23.6**	**19.8**	**11.8**	**5.4**	°C
Specific Conductance	**560**	**644**	**535**	**576**	**517**	**526**	uS / cm
Dissolved Oxygen	NM	NM	NM	NM	NM	NM	mg / L

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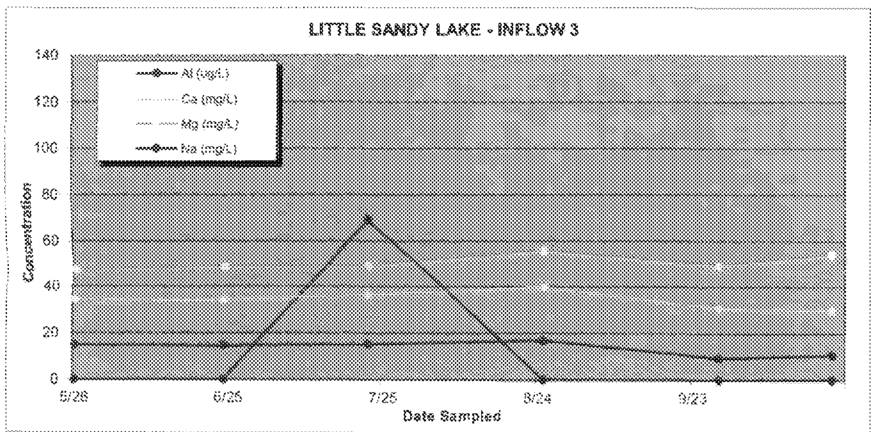
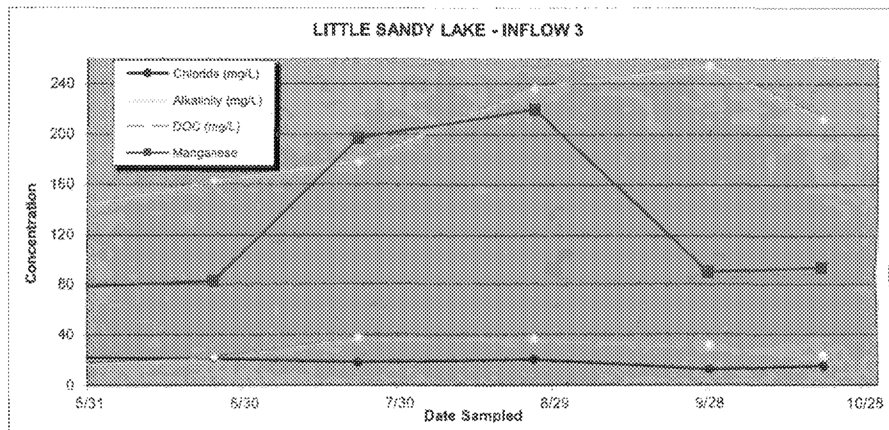
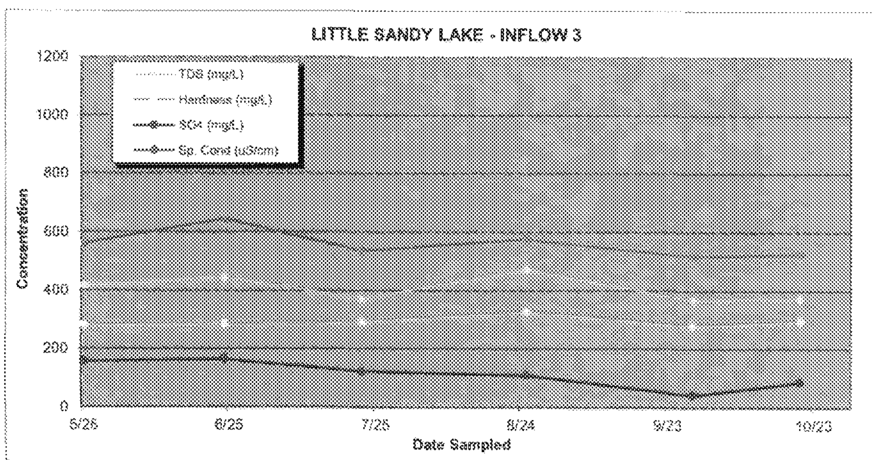
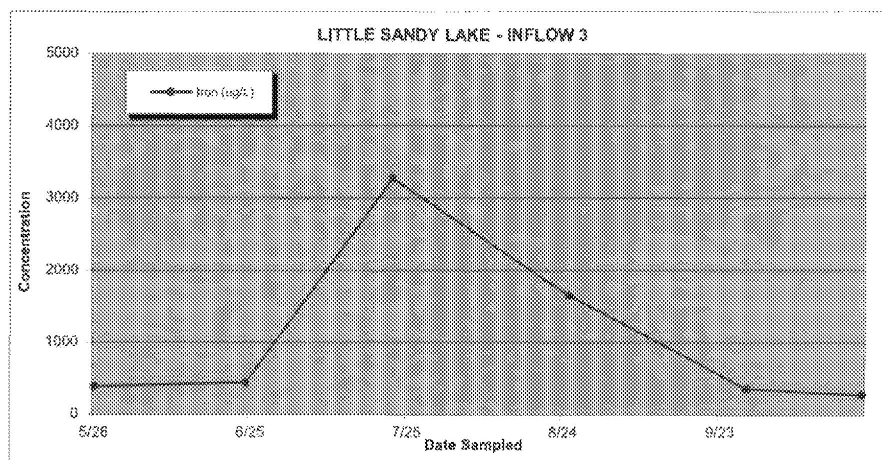
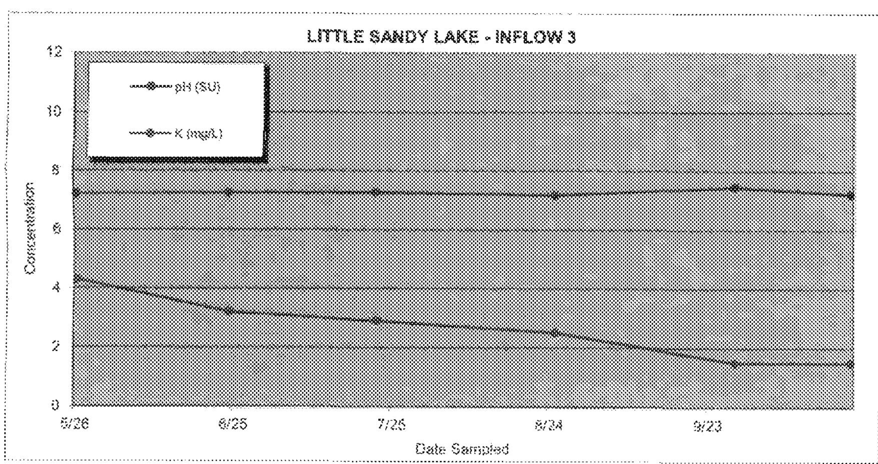
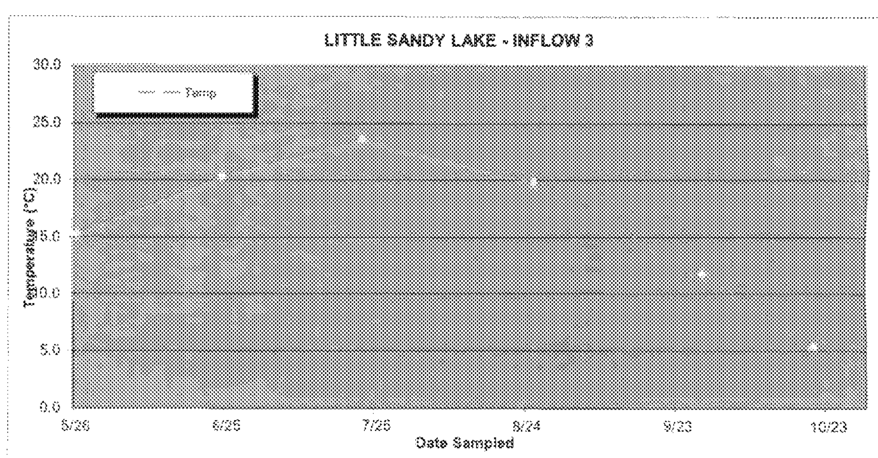








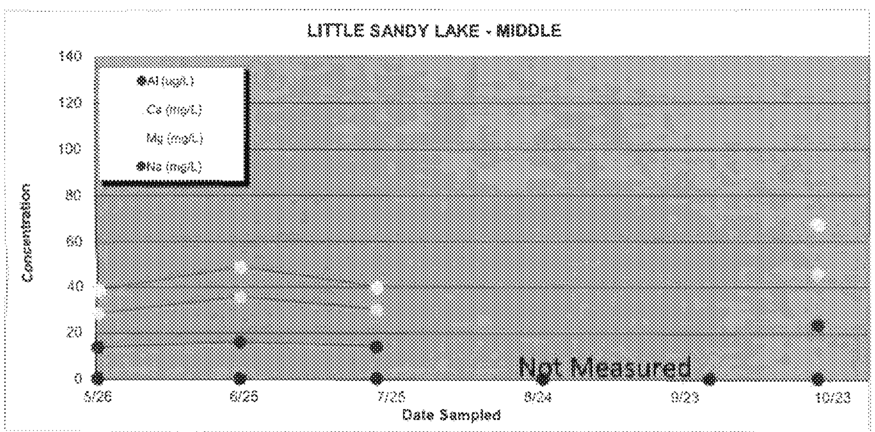


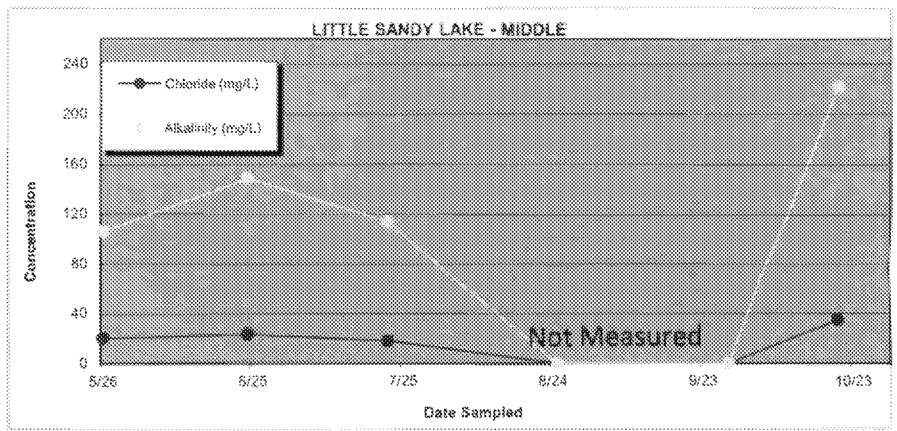


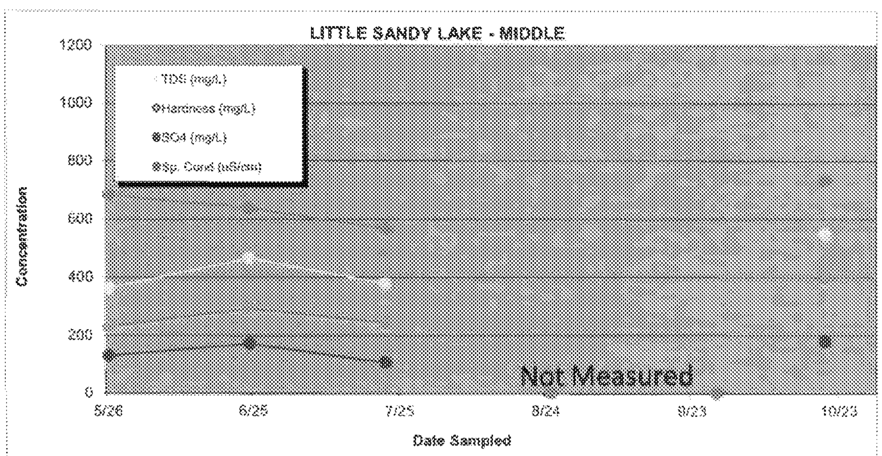
LITTLE SANDY LAKE - MIDDLE

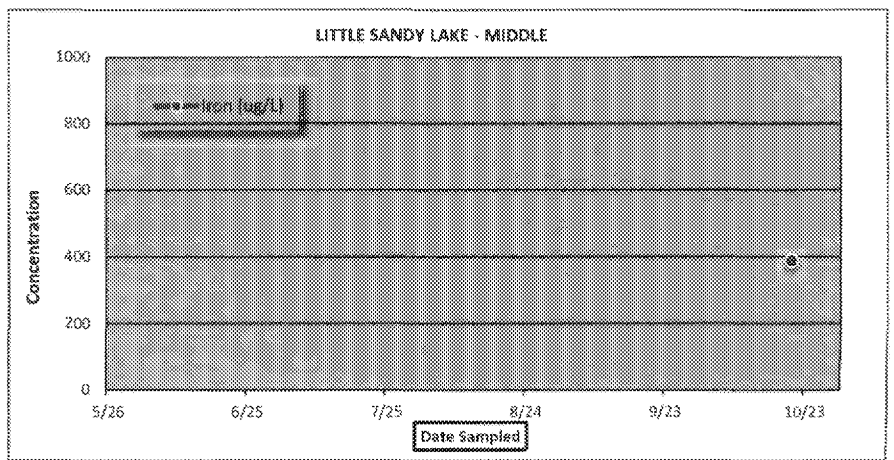
Analytes - Cations	5/26/2016 Little Sandy Middle	6/24/2016 Little Sandy Middle	7/22/2016 Little Sandy Middle	8/25/2016 Little Sandy Middle	9/28/2016 Little Sandy Middle	10/20/2016 Little Sandy Middle	Reporting Units
Aluminum	NM	NM	NM	NM	NM	<50.0	µg / L
Arsenic	NM	NM	NM	NM	NM	NM	µg / L
Barium	NM	NM	NM	NM	NM	NM	µg / L
Calcium	**28.2**	**35.5**	**30.1**	NM	NM	**46.0**	mg / L
Iron	NM	NM	NM	NM	NM	**388**	µg / L
Magnesium	**38.3**	**48.9**	**39.7**	NM	NM	**67.2**	mg / L
Manganese	NM	NM	NM	NM	NM	**63.3**	µg / L
Phosphorus	NM	NM	NM	NM	NM	NM	mg / L
Potassium	NM	NM	NM	NM	NM	**4.1**	mg / L
Rubidium	NM	NM	NM	NM	NM	NM	µg / L
Sodium	**13.5**	**15.9**	**13.8**	NM	NM	**23.0**	mg / L
Strontium	NM	NM	NM	NM	NM	NM	µg / L
Analytes - Anions	==========	==========	==========	==========	==========	==========	==========
Chloride	**19.8**	**23.0**	**17.8**	NM	NM	**34.7**	mg / L
Nitrogen, Kjeldahl, Total	NM	<0.50	**1.4**	NM	NM	**0.75**	mg / L
Ammonium as Nitrogen	NM	<0.10	0.15	NM	NM	<0.10	mg / L
Sulfate	**129**	**170**	**104**	NM	NM	**176**	mg / L
Analytes - Other	==========	==========	==========	==========	==========	==========	==========
Total Dissolved Solids	**363**	**465**	**378**	NM	NM	**548**	mg / L
Total Suspended Solids	NM	**3.2**	**2.0**	NM	NM	**2.4**	mg / L
Alkalinity, Total as CaCO3	**106**	**149**	**114**	NM	NM	**222**	mg / L
Dissolved Organic Carbon	NM	NM	NM	NM	NM	**21.6**	mg / L
Total Hardness by 2340B	**228**	**290**	**239**	NM	NM	**392**	mg / L
UV Absorbance @ 254 nm	NM	NM	NM	NM	NM	NM	cm^{-1}
SUVA	NM	NM	NM	NM	NM	NM	L / mg*m
YSI Probe Plus Data	==========	==========	==========	==========	==========	==========	==========
pH	**8.2**	**7.7**	**7.3**	NM	NM	**8.0**	Units
Temperature	**18.2**	**22.8**	**25.1**	NM	NM	**7.6**	°C
Specific Conductance	**682**	**637**	**567**	NM	NM	**732**	uS / cm
Dissolved Oxygen	NM	NM	NM	NM	NM	NM	mg / L

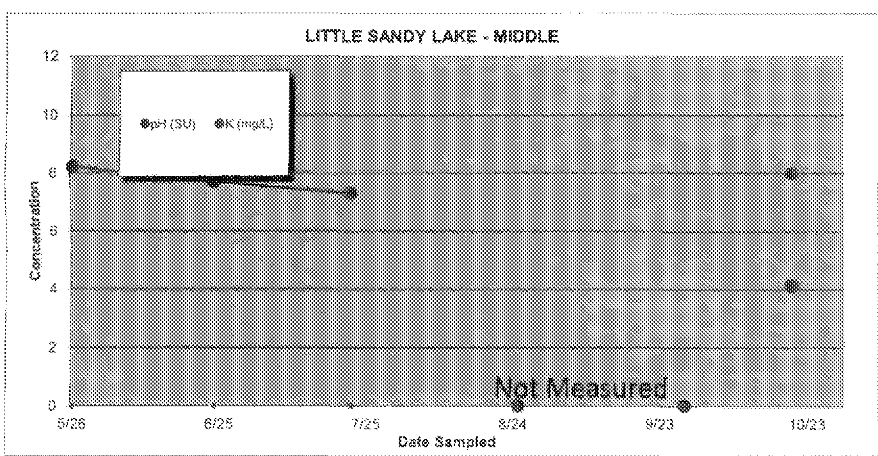
Bold Print indicates the sample is above the detection limit
NM indicates that the analyte was not measured
"<" indicates value below reporting limit
For a list of reporting detection limits, see data tables organized by sample date

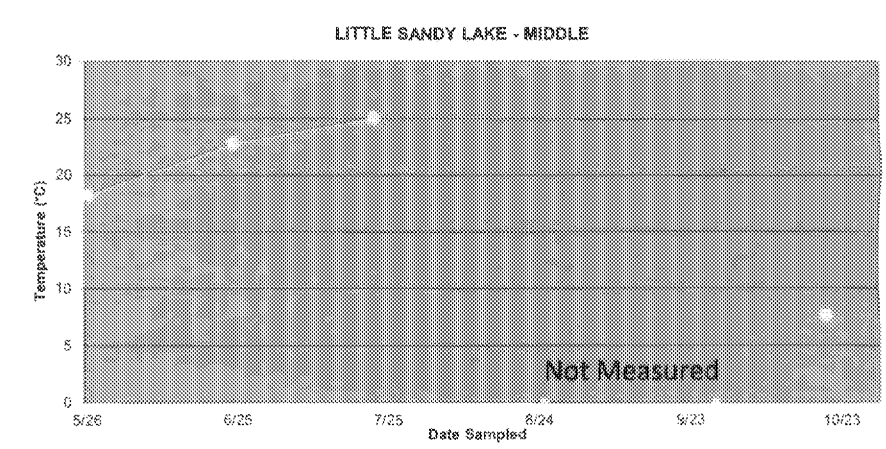








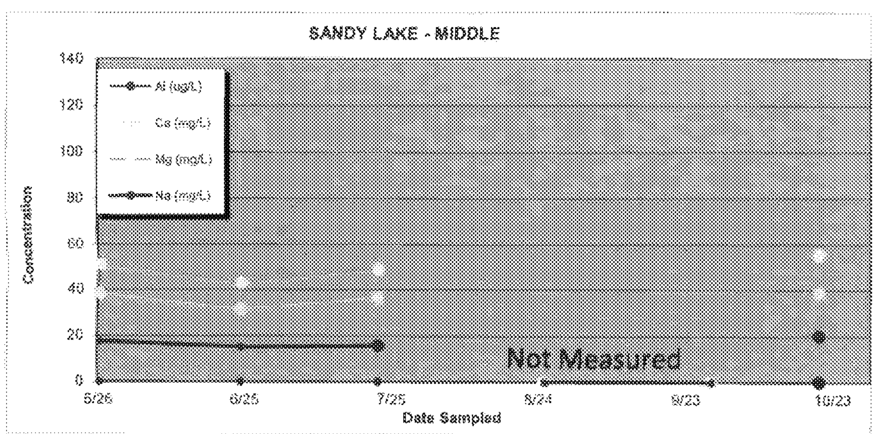


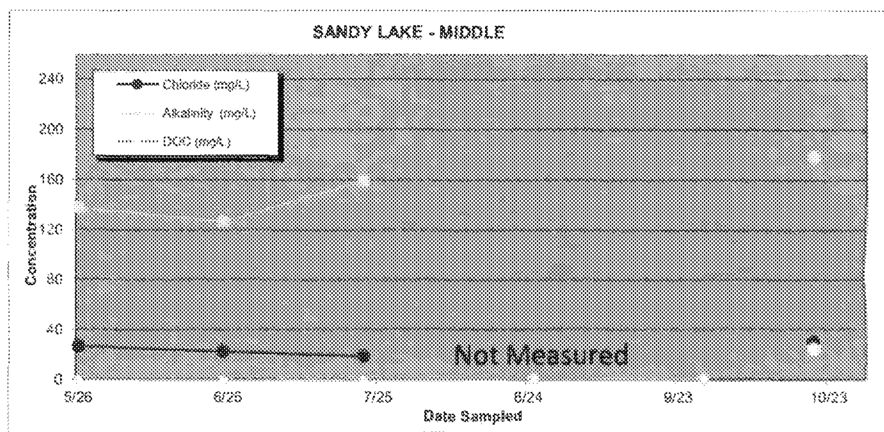


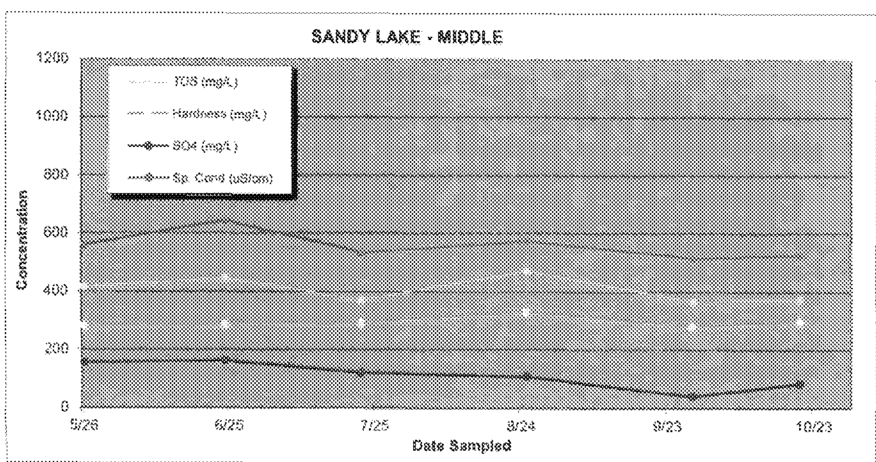
SANDY LAKE - MIDDLE

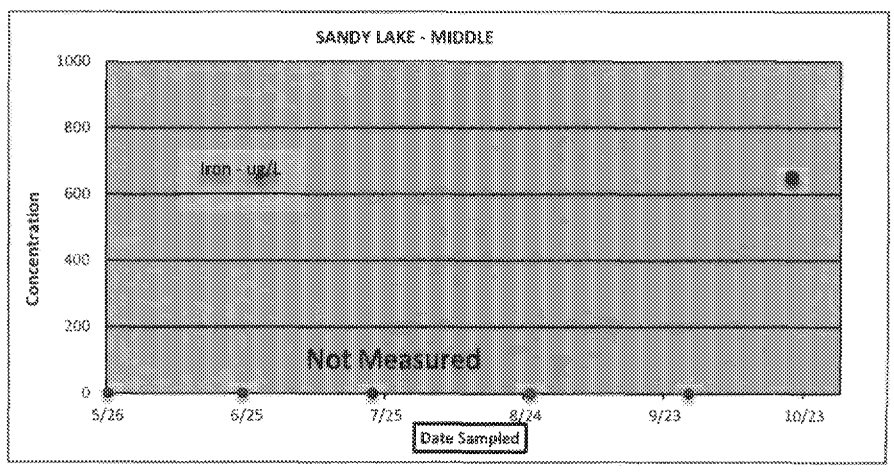
Analytes - Cations	5/26/2016 Sandy Middle	6/24/2016 Sandy Middle	7/22/2016 Sandy Middle	8/25/2016 Sandy Middle	9/28/2016 Sandy Middle	10/20/2016 Sandy Middle	Reporting Units
Aluminum	NM	NM	NM	NM	NM	<50.0	µg / L
Arsenic	NM	NM	NM	NM	NM	NM	µg / L
Barium	NM	NM	NM	NM	NM	NM	µg / L
Calcium	**38.3**	**31.5**	**36.5**	NM	NM	**38.7**	mg / L
Iron	NM	NM	NM	NM	NM	**650**	µg / L
Magnesium	**51.3**	**42.9**	**49.1**	NM	NM	**55.6**	mg / L
Manganese	NM	NM	NM	NM	NM	**38.4**	µg / L
Phosphorus	NM	NM	NM	NM	NM	NM	mg / L
Potassium	NM	NM	**3.0**	NM	NM	**3.6**	mg / L
Rubidium	NM	NM	NM	NM	NM	NM	µg / L
Sodium	**17.5**	**15.2**	**15.6**	NM	NM	**20.1**	mg / L
Strontium	NM	NM	NM	NM	NM	NM	µg / L
Analytes - Anions	==========	==========	==========	==========	==========	==========	==========
Chloride	**26.4**	**22.0**	**18.4**	NM	NM	**30.2**	mg / L
Nitrogen, Kjeldahl, Total	NM	<0.50	**1.3**	NM	NM	**0.79**	mg / L
Ammonium as Nitrogen	NM	<0.10	**0.11**	NM	NM	<.010	mg / L
Sulfate	**183**	**147**	**125**	NM	NM	**135**	mg / L
Analytes - Other	==========	==========	==========	==========	==========	==========	==========
Total Dissolved Solids	**438**	**389**	**398**	NM	NM	**460**	mg / L
Total Suspended Solids	NM	**1.2**	<1.0	NM	NM	**1.6**	mg / L
Alkalinity, Total as CaCO3	**138**	**127**	**160**	NM	NM	**179**	mg / L
Dissolved Organic Carbon	NM	NM	NM	NM	NM	**25.1**	mg / L
Total Hardness by 2340B	**307**	**255**	**293**	NM	NM	**326**	mg / L
UV Absorbance @ 254 nm	NM	NM	NM	NM	NM	NM	cm^{-1}
SUVA	NM	NM	NM	NM	NM	NM	L / mg*m
YSI Probe Plus Data	==========	==========	==========	==========	==========	==========	==========
pH	**8.1**	**7.7**	**7.3**	NM	NM	**8.0**	Units
Temperature	**17.6**	**22.3**	**24.8**	NM	NM	**7.3**	°C
Specific Conductance	**517**	**540**	**459**	NM	NM	**619**	uS / cm
Dissolved Oxygen	NM	NM	NM	NM	NM	NM	mg / L

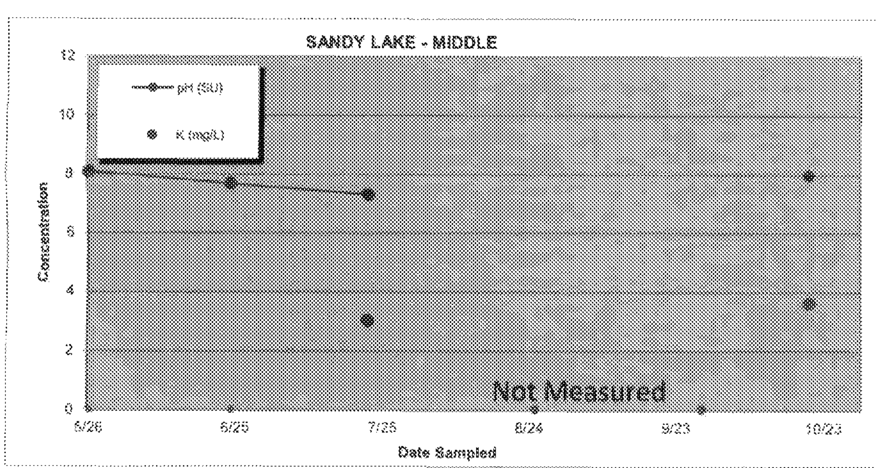
Bold Print indicates the sample is above the detection limit
NM indicates that the analyte was not measured
"<" indicates value below reporting limit
For a list of reporting detection limits, see data tables organized by sample date

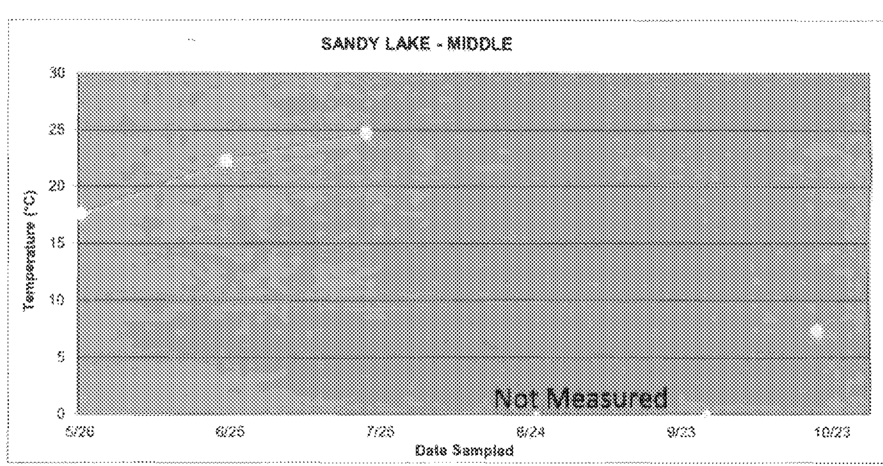












TWIN LAKES OUTFLOW

Analytes - Cations	5/26/2016 Twin Lakes Outflow	6/24/2016 Twin Lakes Outflow	7/22/2016 Twin Lakes Outflow	8/25/2016 Twin Lakes Outflow	9/28/2016 Twin Lakes Outflow	10/20/2016 Twin Lakes Outflow	Reporting Units
Aluminum	<0.50	<200	**51**	**57.3**	<50.0	<50.0	µg / L
Arsenic	NM	NM	NM	NM	NM	NM	µg / L
Barium	NM	NM	NM	NM	NM	NM	µg / L
Calcium	**24.3**	**25.2**	**27.4**	**28.0**	**28.6**	**33.4**	mg / L
Iron	**502**	**724**	**2510**	**3280**	**1420**	**880**	µg / L
Magnesium	**31.2**	**33.4**	**35.3**	**33.4**	**36.0**	**46.5**	mg / L
Manganese	**46.8**	**70.6**	**138**	**136**	**54.1**	**68.1**	µg / L
Phosphorus	NM	NM	NM	NM	NM	NM	mg / L
Potassium	**3.5**	**3.1**	**2.8**	**2.2**	**2.6**	**3.1**	mg / L
Rubidium	NM	NM	NM	NM	NM	NM	µg / L
Sodium	**11.5**	**12.4**	**12.6**	**11.7**	**13.3**	**17.1**	mg / L
Strontium	NM	NM	NM	NM	NM	NM	µg / L
Analytes - Anions	==========	==========	==========	==========	==========	==========	==========
Chloride	**16.4**	**19.5**	**16.8**	**15.4**	**21.1**	**26.1**	mg / L
Nitrogen, Kjeldahl, Total	**0.71**	<0.50	**1.3**	**1.5**	**0.94**	**0.79**	mg / L
Ammonium as Nitrogen	NM	<0.10	**0.13**	**0.32**	**0.11**	<0.10	mg / L
Sulfate	**92.7**	**114**	**92.1**	**64.3**	**81.9**	**109**	mg / L
Analytes - Other	==========	==========	==========	==========	==========	==========	==========
Total Dissolved Solids	**295**	**316**	**276**	**356**	**346**	**392**	mg / L
Total Suspended Solids	NM	**2.0**	**3.6**	<1.0	**2.4**	**2.0**	mg / L
Alkalinity, Total as CaCO3	**92.4**	**105**	**125**	**152**	**145**	**147**	mg / L
Dissolved Organic Carbon	**14.8**	**18.3**	**31.6**	**39.1**	**27.9**	**17.5**	mg / L
Total Hardness by 2340B	**189**	**201**	**214**	**207**	**220**	**349**	mg / L
UV Absorbance @ 254 nm	NM	NM	NM	NM	NM	NM	cm^{-1}
SUVA	NM	NM	NM	NM	NM	NM	L / mg*m
YSI Probe Plus Data	==========	==========	==========	==========	==========	==========	==========
pH	**7.6**	**7.4**	**7.3**	**7.3**	**7.6**	**7.6**	Units
Temperature	**16.2**	**21.3**	**25.0**	**20.0**	**11.0**	**6.5**	°C
Specific Conductance	**359**	**445**	**422**	**417**	**462**	**527**	uS / cm
Dissolved Oxygen	NM	NM	NM	NM	NM	NM	mg / L

Bold Print indicates the sample is above the detection limit
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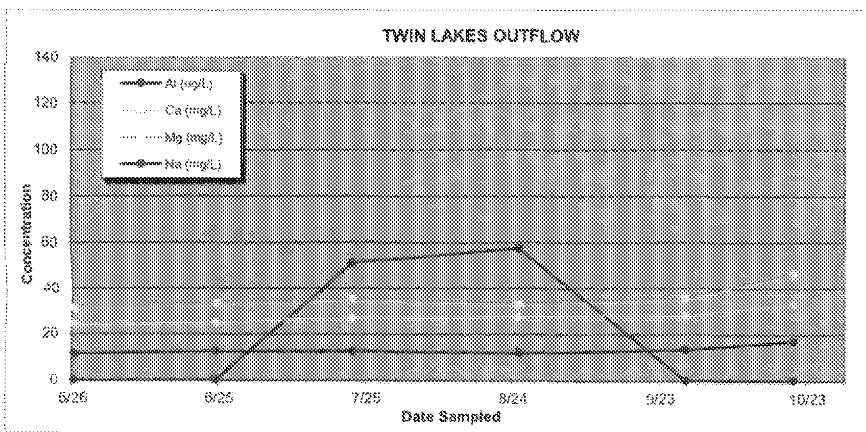
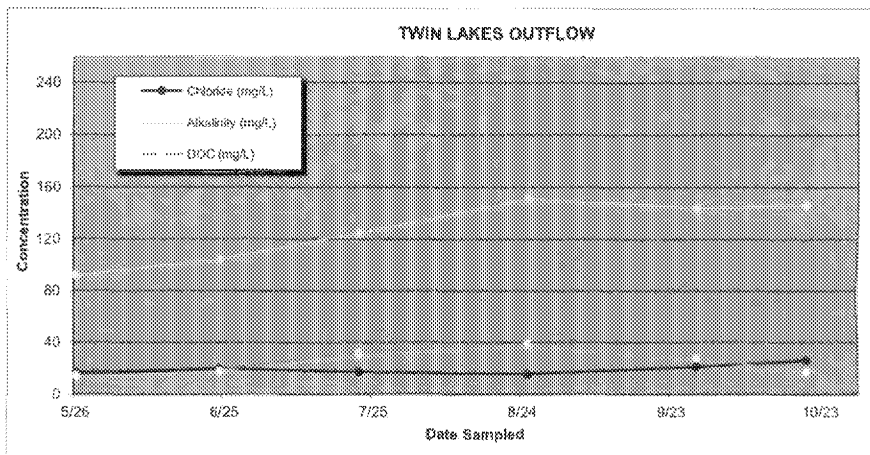
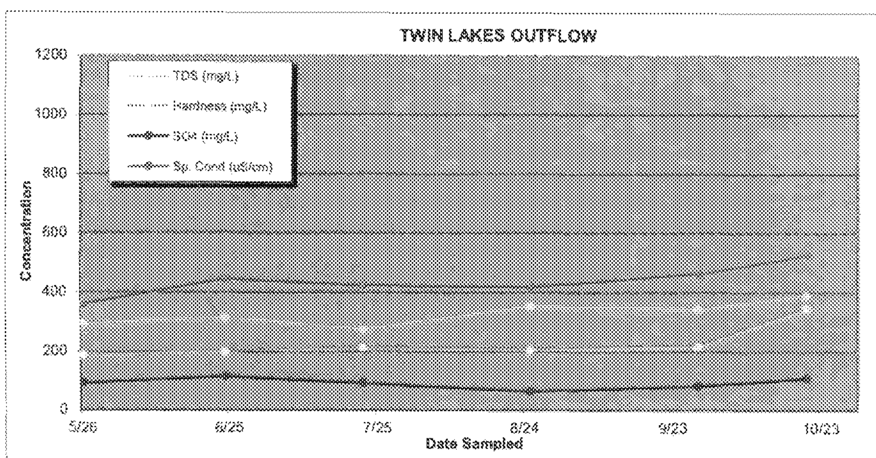
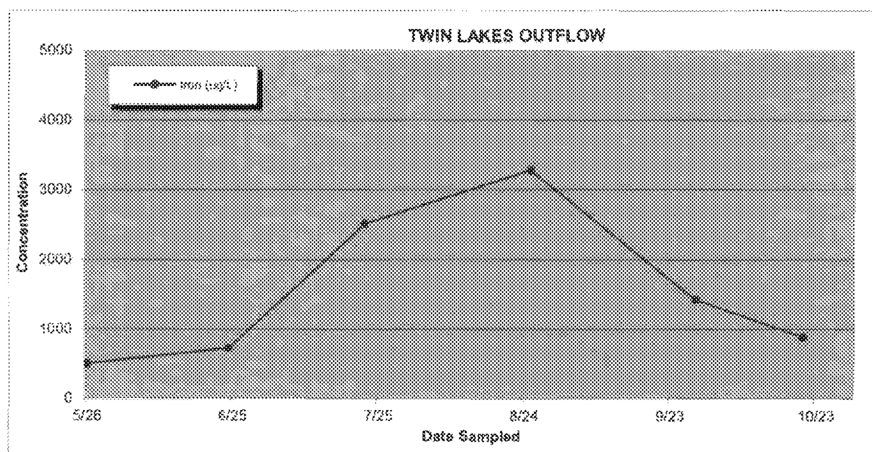
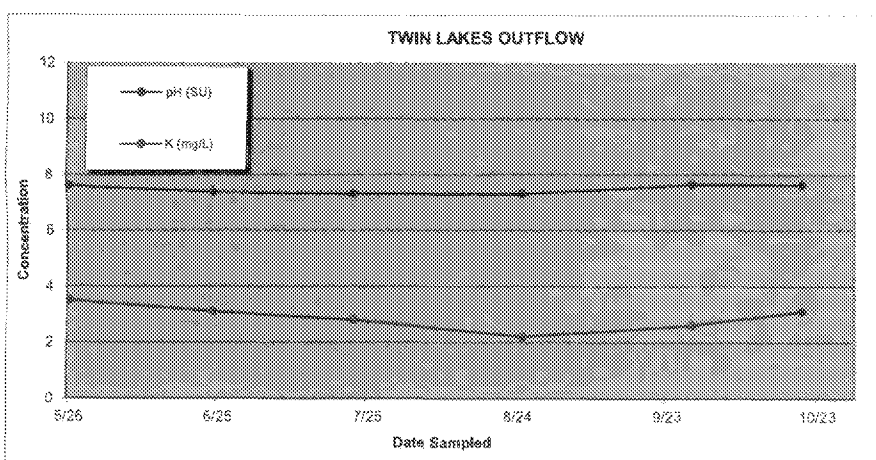
For a list of reporting detection limits, see data tables organized by sample date

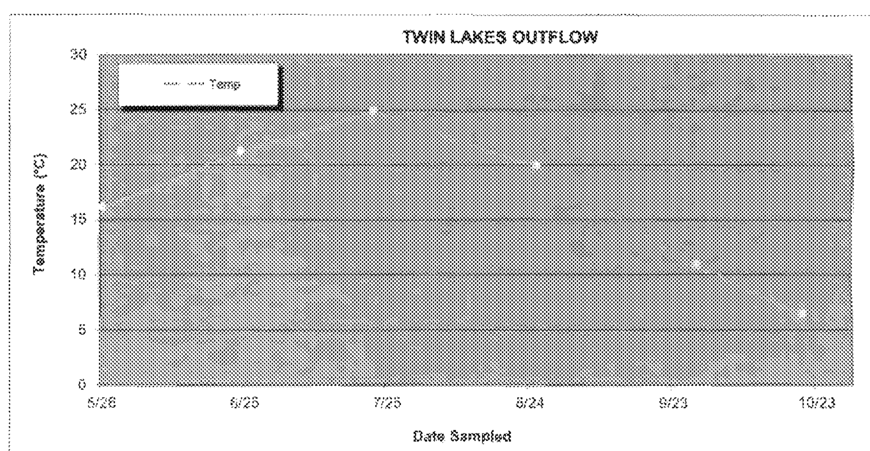








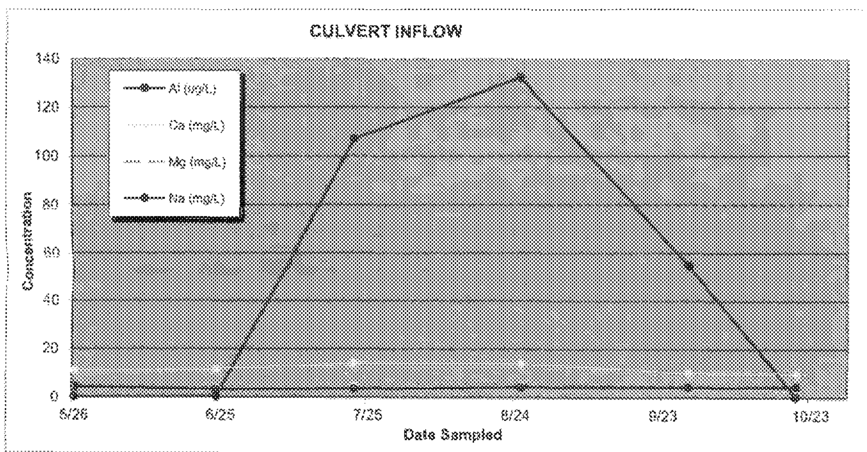


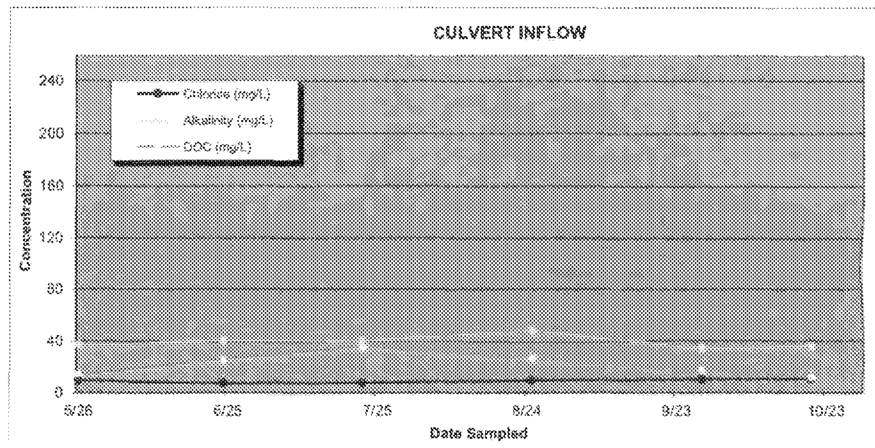


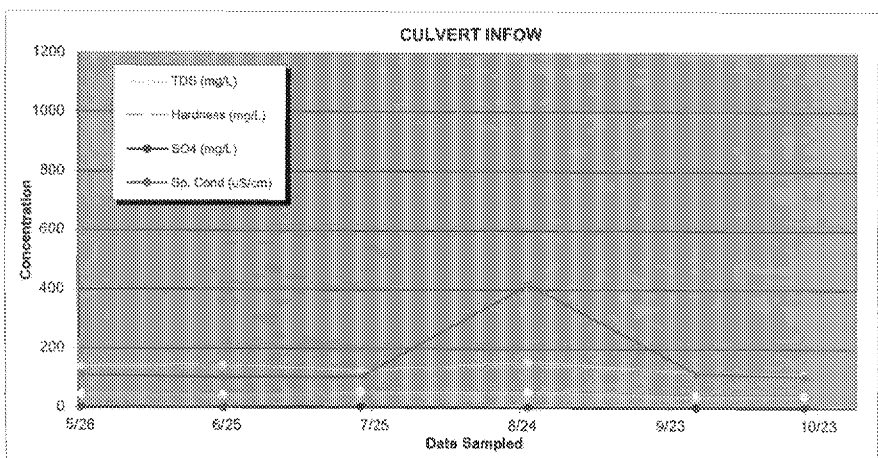
CULVERT INFLOW

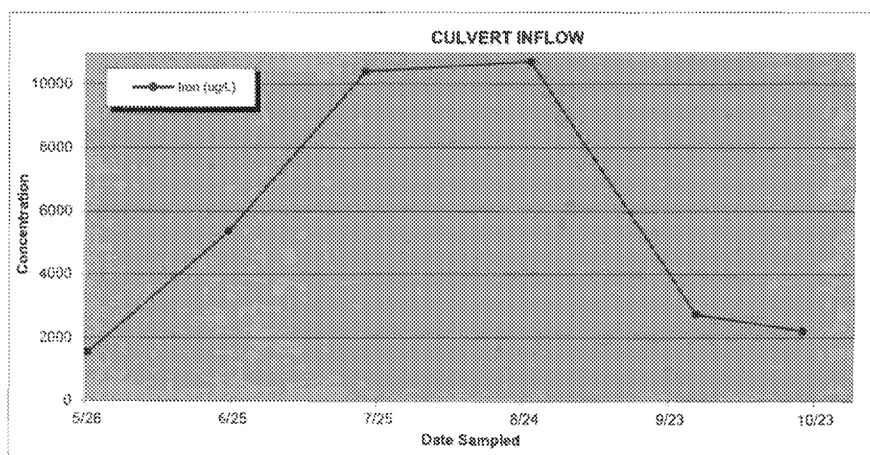
Analytes - Cations	5/26/2016 Culvert Inflow	6/24/2016 Culvert Inflow	7/22/2016 Culvert Inflow	8/25/2016 Culvert Inflow	9/28/2016 Culvert Inflow	10/20/2016 Culvert Inflow	Reporting Units
Aluminum	<0.50	<200	**107**	**132**	**54.5**	<50.0	µg / L
Arsenic	NM	NM	NM	NM	NM	NM	µg / L
Barium	NM	NM	NM	NM	NM	NM	µg / L
Calcium	**11.3**	**11.8**	**14.1**	**14.2**	**10.4**	**10.0**	mg / L
Iron	**1560**	**5360**	**10400**	**10700**	**2750**	**2220**	µg / L
Magnesium	**4.1**	**3.9**	**4.7**	**4.9**	**3.7**	**3.8**	mg / L
Manganese	**62.9**	**411**	**419**	**304**	**101**	**98.7**	µg / L
Phosphorus	NM	NM	NM	NM	NM	NM	mg / L
Potassium	**1.6**	<2.5	**0.94**	**1.1**	**1.76**	**1.6**	mg / L
Rubidium	NM	NM	NM	NM	NM	NM	µg / L
Sodium	**4.1**	**3.1**	**3.4**	**4.1**	**4.0**	**4.2**	mg / L
Strontium	NM	NM	NM	NM	NM	NM	µg / L
Analytes - Anions	==========	==========	==========	==========	==========	==========	==========
Chloride	**9.4**	**7.1**	**7.5**	**9.5**	**10.4**	**10.6**	mg / L
Nitrogen, Kjeldahl, Total	<0.50	**0.67**	**1.3**	**0.99**	<0.60	<0.60	mg / L
Ammonium as Nitrogen	NM	<0.10	**0.12**	<0.10	<0.10	<0.10	mg / L
Sulfate	<2.0	<2.0	**2.3**	<2.0	<2.0	<2.0	mg / L
Analytes - Other	==========	==========	==========	==========	==========	==========	==========
Total Dissolved Solids	**141**	**145**	**126**	**155**	**120**	**113**	mg / L
Total Suspended Solids	NM	NM	**5.0**	**26**	**3.5**	**3.2**	mg / L
Alkalinity, Total as CaCO3	**37.1**	**40.8**	**40.2**	**48.4**	**34.8**	**36.6**	mg / L
Dissolved Organic Carbon	**13.9**	**25.7**	**35.4**	**26.9**	**16.9**	**11.7**	mg / L
Total Hardness by 2340B	**45.1**	**45.6**	**54.5**	**55.5**	**41.2**	**40.4**	mg / L
UV Absorbance @ 254 nm	NM	NM	NM	NM	NM	NM	cm^{-1}
SUVA	NM	NM	NM	NM	NM	NM	L / mg*m
YSI Probe Plus Data	==========	==========	==========	==========	==========	==========	==========
pH	**7.0**	**6.5**	**6.5**	**7.3**	**6.8**	**7.0**	Units
Temperature	**14.2**	**19.8**	**19.2**	**20.0**	**13.1**	**5.8**	°C
Specific Conductance	**112**	**102**	**107**	**417**	**118**	**105**	uS / cm
Dissolved Oxygen	NM	NM	NM	NM	NM	NM	mg / L

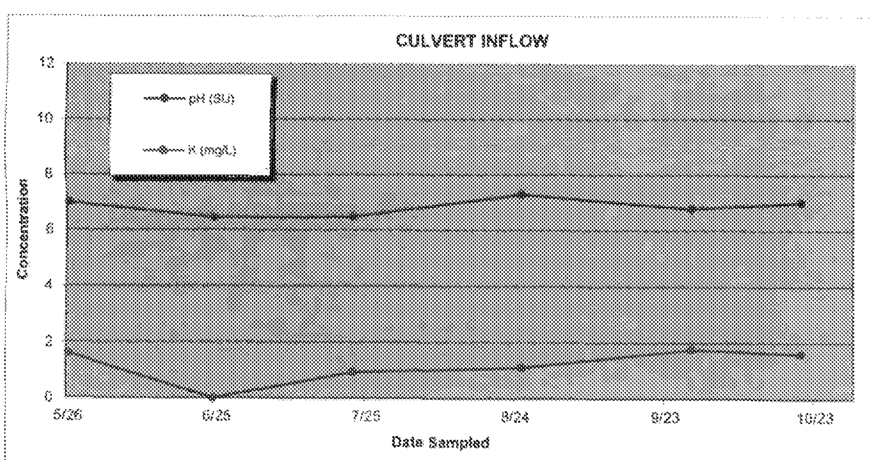
Bold Print indicates the sample is above the detection limit
NM indicates that the analyte was not measured
"<" indicates value below reporting limit
For a list of reporting detection limits, see data tables organized by sample date

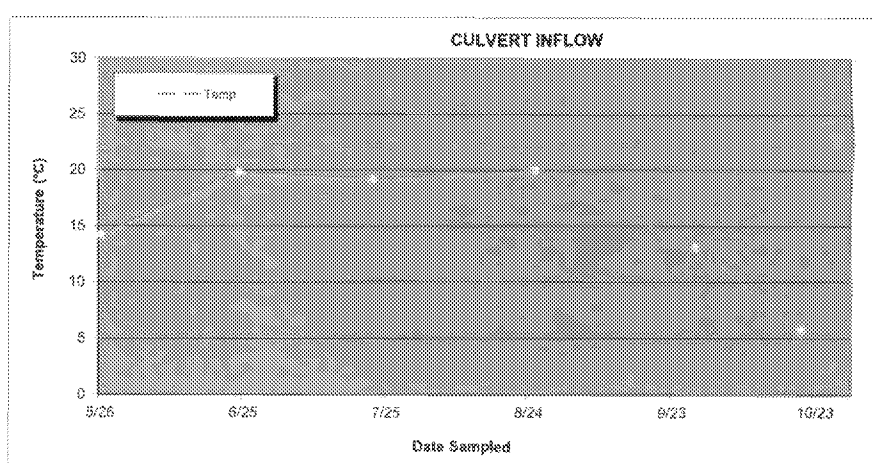








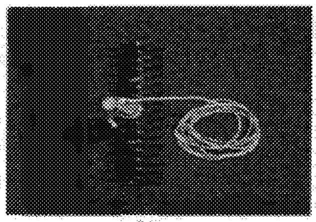




Appendix D

Twin Lakes 2016 Aquatic Plant Survey

2016 Aquatic Plant Survey
22-Aug-16



Double-headed Rake Method

Little Sandy Lake

Transect 1

	Water Depth ft	% Coverage	Plant Name
Station 1	2.0	30	Northern Water Milfoil (1 - 2 plants) & Hard Stem 25%
Station 2	3.75	0	Decomposing plant material; No live plants
Station 3	4.25	0	Detritus only
Station 4	4.25	0	No identifiable Plant taxa

Transect 2

	Water Depth ft	% Coverage	
Station 1	2.25	75	Wild Celery (one plant) & Coontail (70%
Station 2	3.0	50	Northern Water Milfoil
Station 3	3.5	15	Northern Water Milfoil & Wild Celery (1 plant)
Station 4	3.5	2	Wild Celery & Patch of Bur Reed
Station 5	3.75	0	None
Station 6	3.75	0	None

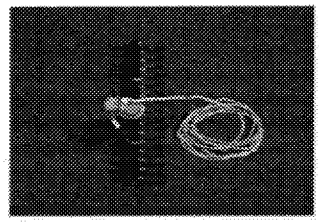
Transect 3

	Water Depth ft	% Coverage	
Station 1	3.0	1.5	Slender Raiad
Station 2	3.5	1.5	Northern Water Milfoil & Slender Raiad (one plant each)
Station 3	4.0	1	Northern Water Milfoil (one plant)
Station 4	4.5	2.5	Northern Water Milfoil (one plant)
Station 5	4.5	0	None
Station 6	4.75	0	None

Transect 4

	Water Depth ft	% Coverage	
Station 1	2.0	0	None
Station 2	3.25	25	Northern Water Milfoil
Station 3	4.0	10	Northern Water Milfoil
Station 4	4.25	0	None

2016 Aquatic Plant Survey
22-Aug-16



Double-headed Rake Method

Sandy Lake

Transect 1		Water Depth ft	% Coverage	Plant Name
	Station 1	2.25	100	Coontail
	Station 2	2.75	20	White Pond Lilly - 2 large leaves
	Station 3	3.0	20	Wild Celery
	Station 4	3.0	100	Coontail
	Station 5	2.75	100	Coontail
	Station 6	2.0	100	Coontail - some Detritus

Transect 2		Water Depth ft	% Coverage	
	Station 1	3.25	20	Northern Bladderwort (living plant - 50%) & Detritus (50%)
	Station 2	3.5	50	Mushgrass (48%) & Northern Water Milfoil (2%)
	Station 3	4.0	100	Northern Water Milfoil (5%) & Mushgrass (95%)
	Station 4	4.5	25	Northern Badderwort (2%), Pondweed (5%) & Northern Water Milfoil
	Station 5	4.0	10	Northern Water Milfoil
	Station 6	4.0	5	Northern Water Milfoil

Transect 3		Water Depth ft	% Coverage	
	Station 1	1.75	20	Wild Rice
	Station 2	3.25	2	Slender Raiad (1 plant)
	Station 3	3.25	0	None
	Station 4	3.5	20	N. Bladderwort (2%) and Spatterdock (18%)
	Station 5	3.75	3	Spatterdock (1%), Detritus (1%) & Spatterdock (18%)
	Station 6	4.0	60	N. Bladderwort (25%), Bur Reed (30%, with Small pondweed & White Stemmed Pondweed

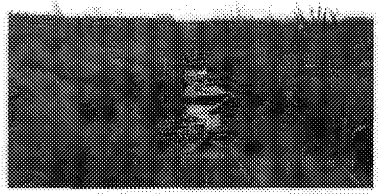
Transect 4		Water Depth ft	% Coverage	
	Station 1	2.5	15	Bur Reed
	Station 2	3.5	0	None
	Station 3	4.5	5	Pondweed (none identifiable pondweed)
	Station 4	4.25	1	Chara sp.
	Station 5	4.25	1	Detritus - possible Chara sp.
	Station 6	4.5	1	Northern Water Milfoil

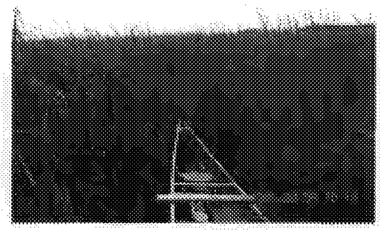
Appendix E

Twin Lakes 2016 Field Pictures

Twin Lakes Pictures in 2016


Twin Lake's Landing Area

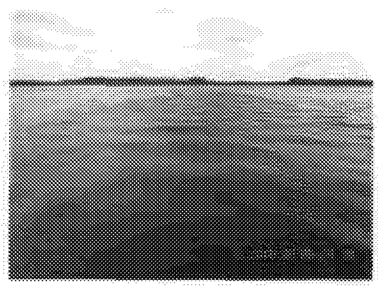

Canoe Landing North

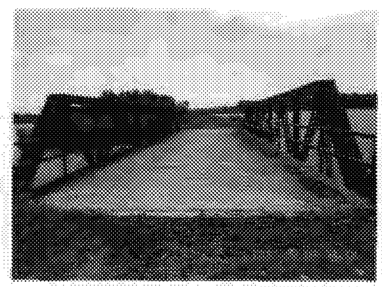

Typical shoreline of Twin Lakes


Sandy Lake Outflow


Sandy Lake East


Sandy Lake Looking Northwest




Twin Lakes Bridge


By Bridge Looking North


View of old Road under water


Looking South – PT visable

Twin Lakes Pictures in 2016

Location of Staff Gauge

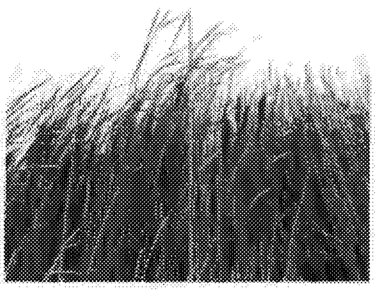
Little Sandy Lake – South

Inflow 1 Location

Old Bridge at Inflow 1

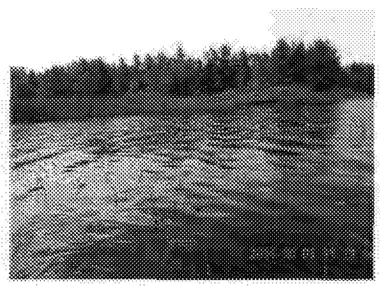
Sandy Lake Looking North

Sandy Lake Rice Bed



Typical Lake Edge

Aquatic Plant Life



Rice Bed

Sandy Lake looking NW

Little Sandy Lake

Sandy Lake

Twin Lakes Aquatic Plant Survey Pictures
August 22, 2016 Page 1

Little Sandy Lake Inflow 1

Twin Lakes Aquatic Plant Survey Pictures
August 22, 2016 Page 2

Little Sandy Lake Transect T2 - 1

Little Sandy Lake Transect T2 Wild Celery

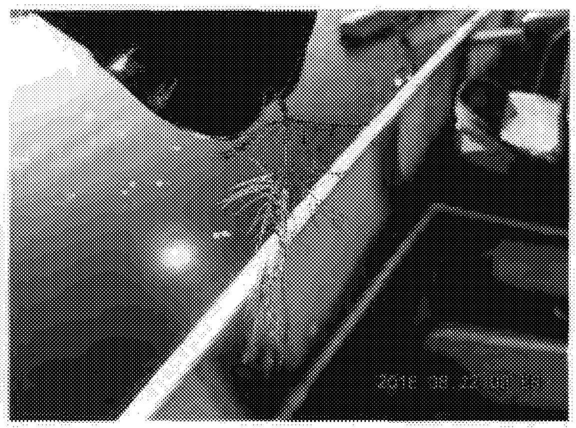
Little Sandy Lake Transect T2 Coontail

Twin Lakes Aquatic Plant Survey Pictures
August 22, 2016 Page 3

Little Sandy Lake Transect 2 - 2

Northern Water Milfoil

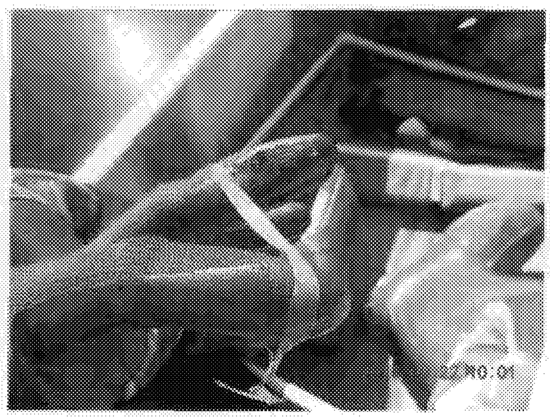
Little Sandy Lake Transect 2-3



Twin Lakes Aquatic Plant Survey Pictures
August 22, 2016 Page 4

Little Sandy Lake Transect T - 2

Little Sandy Lake Transect T2 - 4

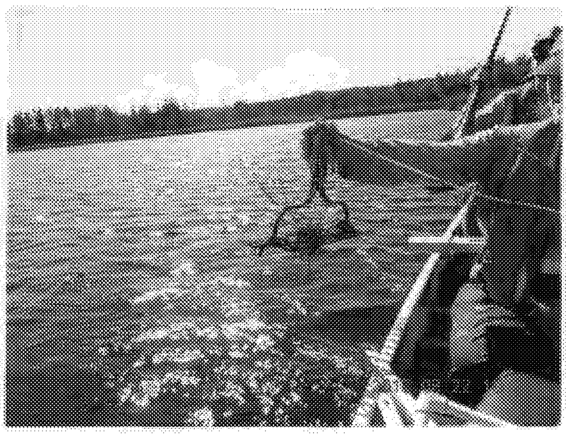


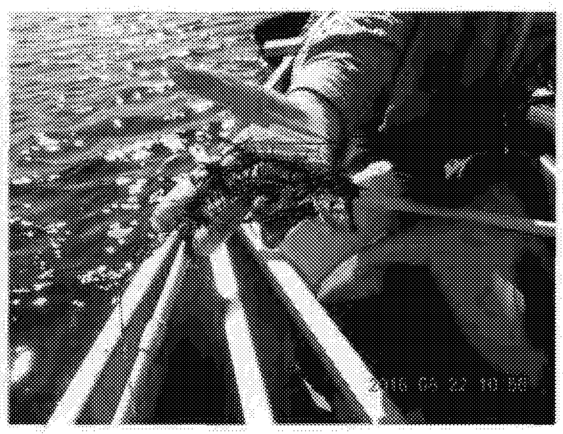
Little Sandy Lake South

Twin Lakes Aquatic Plant Survey Pictures
August 22, 2016 Page 5

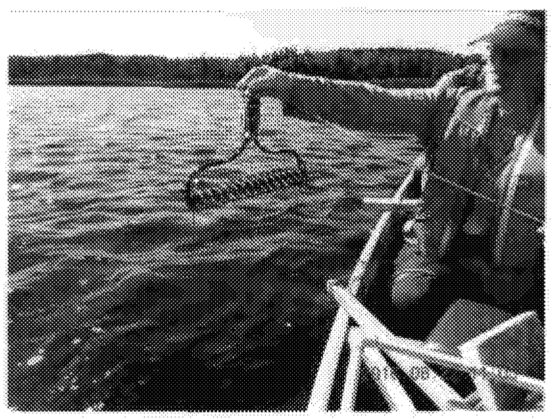
Little Sandy Lake Inflow 2

Little Sandy Lake Transect 3 - 1



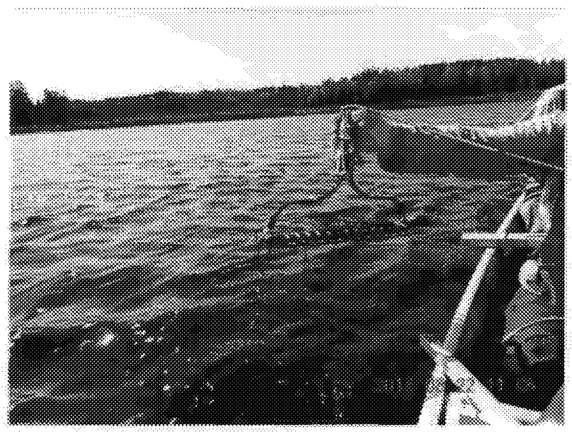


Little Sandy Lake Transect T3 – 2 Slender raiad

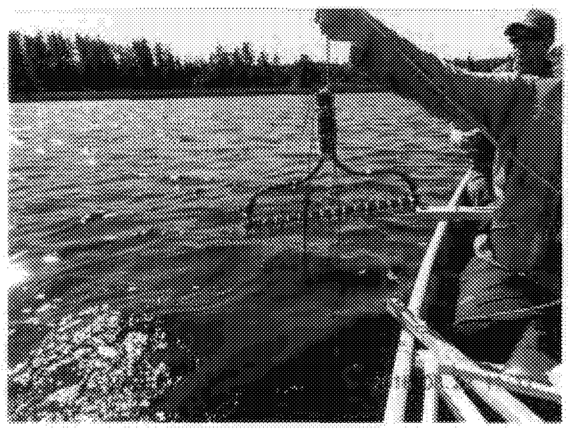


Twin Lakes Aquatic Plant Survey Pictures
August 22, 2016 Page 6

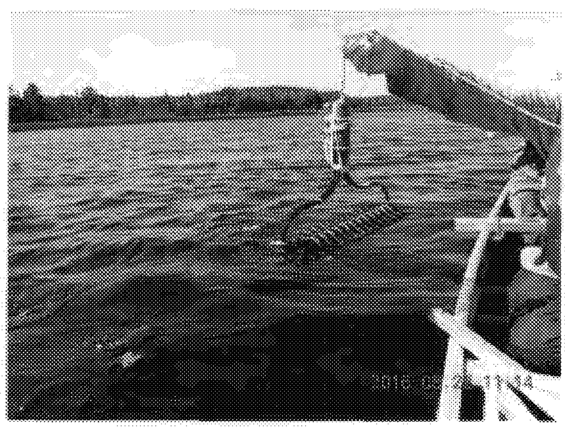
Little Sandy Lake Transect T3 - 3



Little Sandy Lake Transect T3 – 4

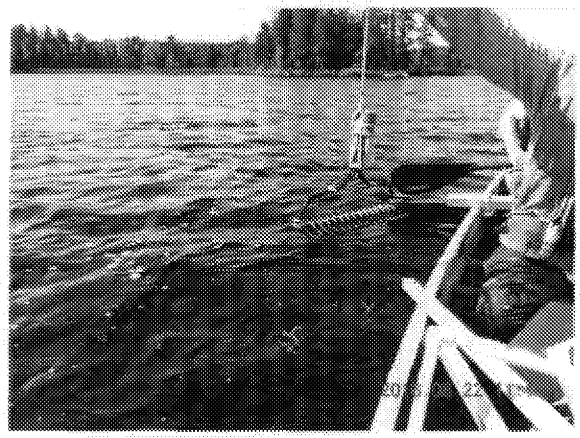


Little Sandy Lake Transect T3 - 5

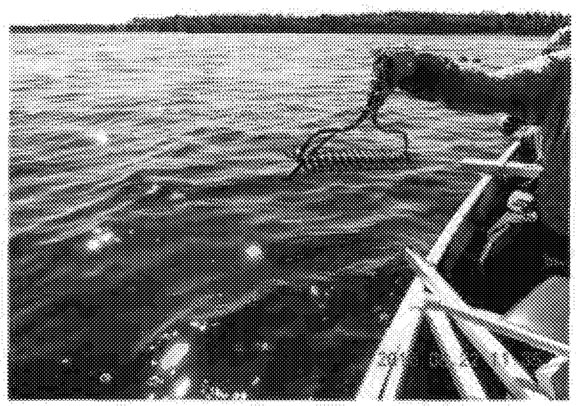


Twin Lakes Aquatic Plant Survey Pictures
August 22, 2016 Page 7

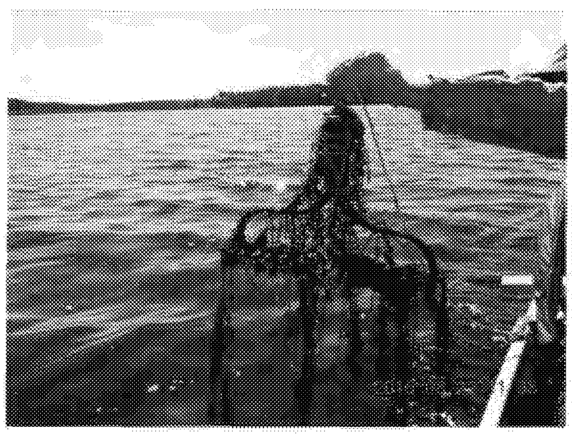
Little Sandy Lake T3 - 6



Little Sandy Lake T4 - 1



Little Sandy Lake T4 - 2

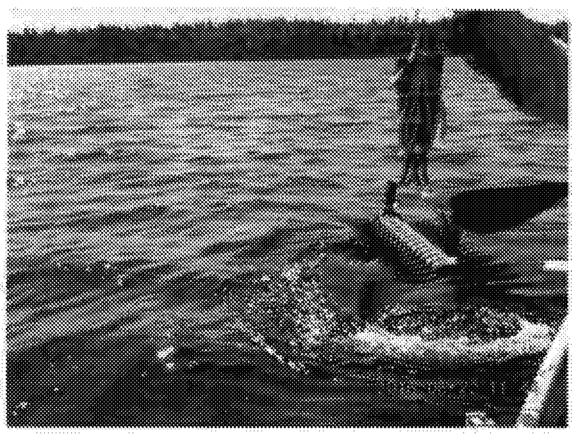


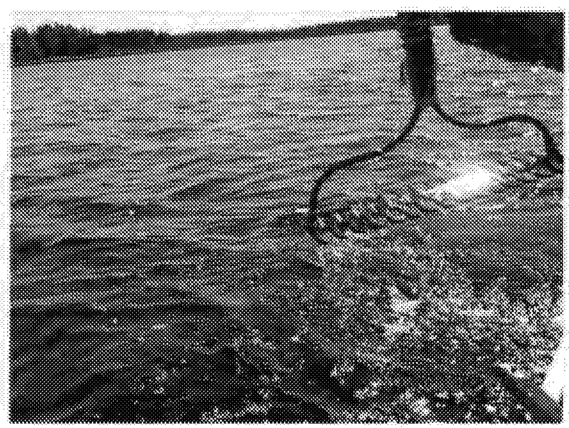
Twin Lakes Aquatic Plant Survey Pictures
August 22, 2016 Page 8

Little Sandy Lake Transect T4 - 3

Little Sandy Lake Transect T4 - 4

Little Sandy Lake Transect T1 - 1





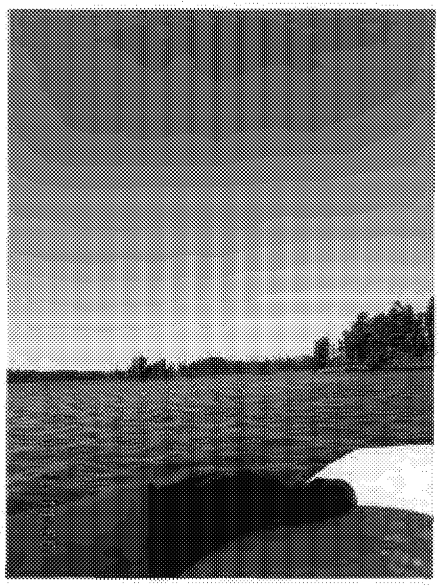
Twin Lakes Aquatic Plant Survey Pictures
August 22, 2016 Page 9

Little Sandy Lake Transect T1 - 1

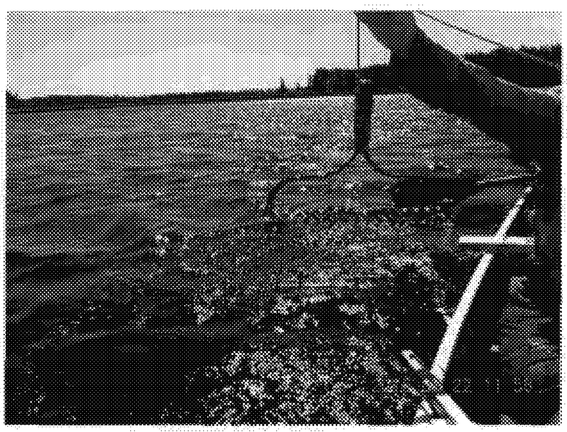
Little Sandy Lake Transect T1 - 2

Twin Lakes Aquatic Plant Survey Pictures
August 22, 2016 Page 10

Little Sandy Lake T1 - 3

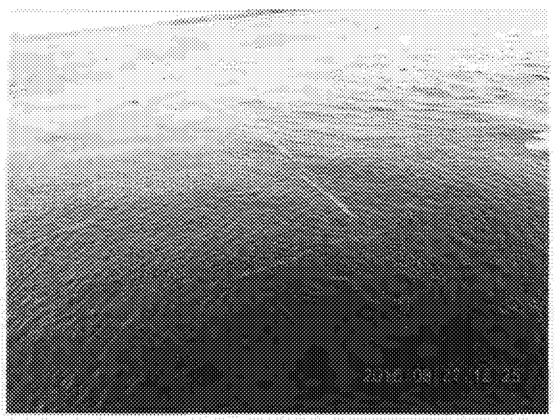


Little Sandy Lake Transect T1 - 4



Twin Lakes Aquatic Plant Survey Pictures
August 22, 2016 Page 11

Sandy Lake Southwest Wild Rice Plot



Twin Lakes Aquatic Plant Survey Pictures
August 22, 2016 Page 12

Sandy Lake Southwest Wild Rice Plot

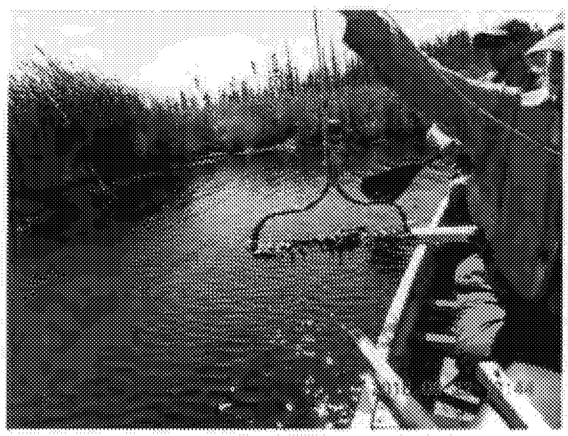
Twin Lakes Aquatic Plant Survey Pictures
August 22, 2016 Page 13

Sandy Lake Transect T3 - 1

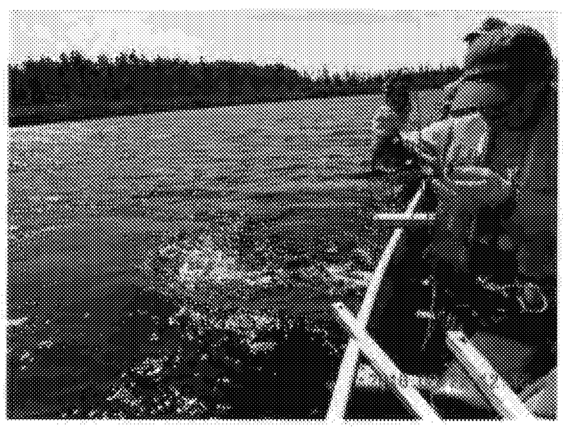





Sandy Lake Transect 3 - 1



Sandy Lake Transect T3 - 2

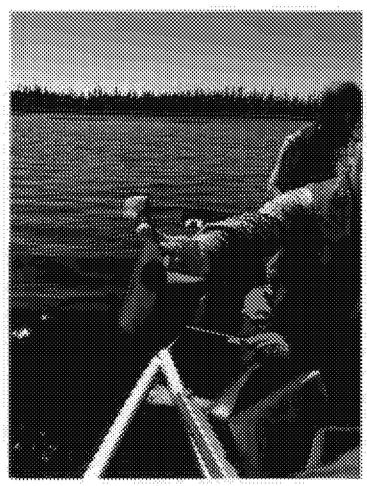


Twin Lakes Aquatic Plant Survey Pictures
August 22, 2016 Page 15

Sandy Lake Transect T3 – 2 Spatterdock

Sandy Lake Transect T3 - 3

Sandy Lake Transect 3 – 4 Spatterdock



Twin Lakes Aquatic Plant Survey Pictures
August 22, 2016

Sandy Lake Transect T3 - 5

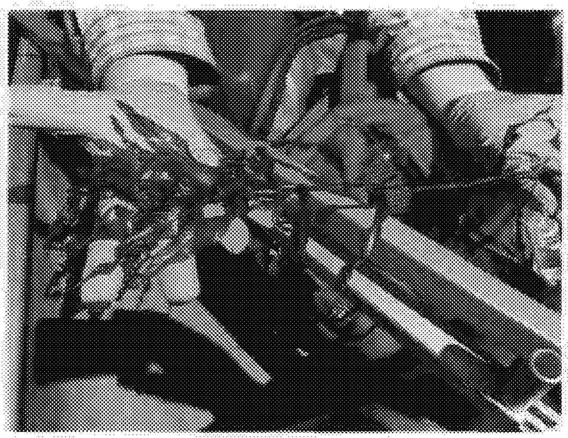
Sandy Lake Transect T3 - 6

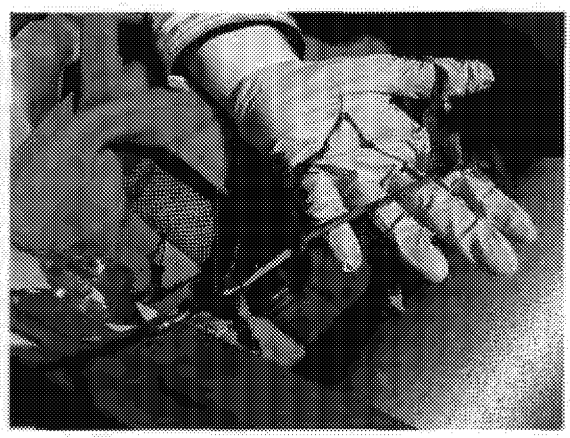
Sandy Lake Transect T3 – 6 Bur Reed

Twin Lakes Aquatic Plant Survey Pictures
August 22, 2016

Sandy Lake Transect T3-6 Small Pondweed

Sandy Lake Transect T3- 6 White Stemmed Pondweed



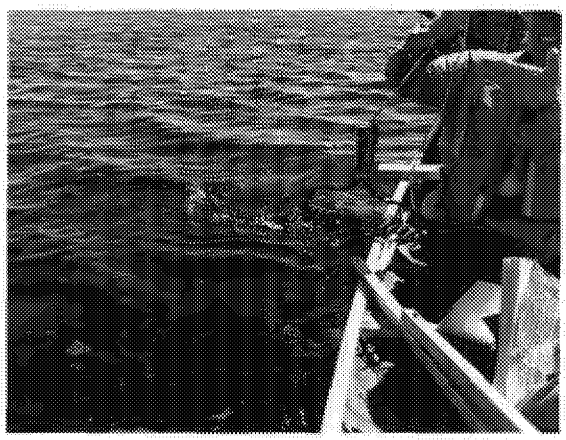


Sandy Lake Transect 4 - 1

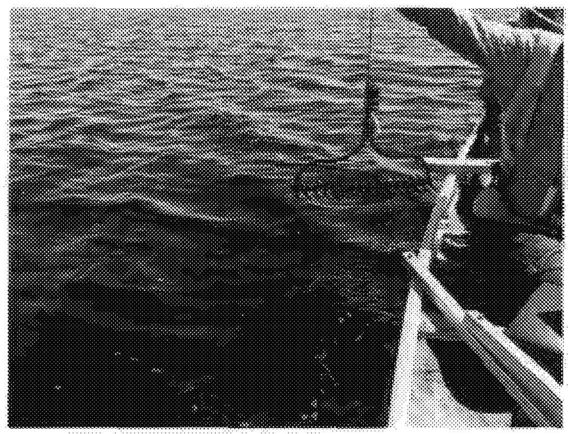
Twin Lakes Aquatic Plant Survey Pictures
August 22, 2016

Sandy Lake Transect 4 - 3

Sandy Lake Transect 4 - 4

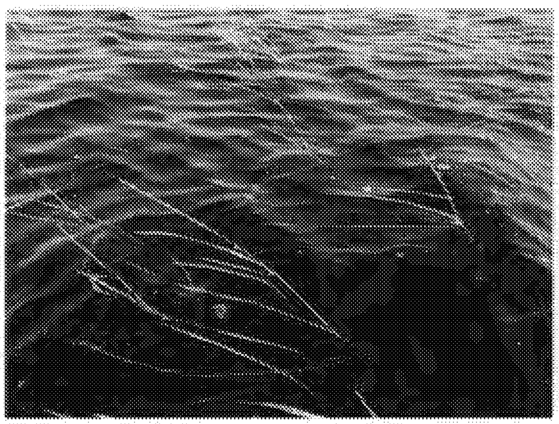


Sandy Lake Transect 4 - 5



Sandy Lake Transect T4 - 6

Sandy Lake East Wild Rice Plot



Twin Lakes Aquatic Plant Survey Pictures
August 22, 2016

Sandy Lake Transect 1 - 1

Observation of Twin Lakes Planted Wild Rice Growth
August 12, 2016

Sandy Lake Southwest (Close View)

Sandy Lake Southwest (Wide Angle)

Sandy Lake East (Wide Angle)

Sandy Lake East (Close View)

APPENDIX F

2016 Beaver Management Activities

[External]-Twin Lakes Beaver work
Sahr, Duane P \Pete\- APHIS - APHIS   12/14/2016 10:50 AM
To: Tom A Moe

History: This message has been forwarded.

Hi Tom,

We did do some beaver trapping on the Twin Lakes (Sand River) project this spring.

We started trapping May 24 and ended June 8. In that time we caught 8 beaver on the upper stretch (from the Lake to Hwy 53) and 14 beaver on the lower stretch (from Hwy 53 to the Rice River Road (CR 303)). We hand pulled 7 dams (some old, but some new also. Those were fresh stick dams with very little mud).

We went back on August 25 and floated the entire project and pulled 4 older dams that were exposed by lower water levels. No new beaver sign.

We purchased a mud motor this summer, which was the only way we were able to motor on the river in August because the system was pretty weed choked. Would have really been tough otherwise.

Let me know if you need anything else.

Thanks

Duane P. Sahr
Duane (Pete) Sahr
Wildlife Biologist
USDA/APHIS/Wildlife Services
34912 US Hwy 2
Grand Rapids, MN 55744
Duane.P.Sahr@aphis.usda.gov
(218) 327-3350 phone
(218) 326-7039 fax

Appendix G

2016 Observations of Wild Rice Pilot Seeding Plots

Observation of Twin Lakes Planted Wild Rice Growth
August 9 & 22, 2016

Sandy Lake; Northwest

- Counted 31 wild rice plants with ½ in Aerial Phase
- One wild rice plant has flower/seed pods
- Observed wild rice stalks that have been bitten off
- Water depth in rice bed: Between 2.7' and 3.9'
- Most plants observed in 2.7' to 2.9' of water depth
- Flowers observed between 12" and 18" above water surface

Sandy Lake; East

- Over 200 wild rice plants with ½ in Aerial Phase
- Patchy growth with 5.5 wild rice plants per square meter
- Many plants observed flowering
- Observed wild rice stalks that have been bitten off
- Water depth in rice bed: 3.8' to 4.0'
- Flowers observed between 12" and 18" above water surface

Sandy Lake; Southwest

- Over 200 wild rice plants with ½ in Aerial Phase
- Very patchy growth with 11 wild rice plants per square meter
- About half of the Aerial Phase plants flowering
- Observed wild rice stalks that have been bitten off
- Water depth in rice bed: 3.5'
- Little to no competitive vegetation in wild rice plot area
- Wild rice is taller, more stout/rigid than Northwest & East plants

Little Sandy; Lake South

- Over 200 wild rice plants with ½ I Aerial Phase
- Patchy growth with 30 wild rice plants per square meter
- A lot of Bur Reed competition in planted wild rice plot
- Some of the plants flowering, all between 12" and 18" above water surface
- Water depth in rice bed: 3.75' to 4.0'
- Little to no competitive vegetation in wild rice plot area

Little Sandy Lake; Northwest

- No evidence of wild rice growing in this plot

Little Sandy Lake; Northeast

- Approximately 10 wild rice plants found in plot
- Plants were only in floating leaf stage
- Water depth in rice bed: 3.2' to 3.9'

Peeper Porewater Analysis in Twin Lakes Rice Beds

August 25 to September 28, 2016

	Units	Reportable Detection Limit	Sandy Lake East	Sandy Lake NW	Sandy Lake SW	Sandy Lake South (Natural)*	Little Sandy South
Sulfide	mg/L	0.10	<0.10	<0.10	<0.10	**0.15**	<0.10
Iron	ug/l	50.0	**505**	**1150**	**1210**	**37700**	**15400**
Sulfate	mg/L	10.0	**370**	**358**	**107**	**284**	**423**
NO2 as N	mg/L	0.20	<0.20	<0.20	<0.20	<0.20	<0.20
NO3 as N	mg/L	0.20	<0.20	<0.20	<0.20	<0.20	<0.20
N, NH3	mg/L	0.10	<0.10	<0.11	<0.12	<0.13	<0.14
N. Kjeldahl	mg/L	2.5	**3.7**	**3.9**	<2.5	**14.2**	<2.5
Phos (Tot)	mg/L	0.50/0.10	<0.50	**0.12**	<0.10	**1.8**	<0.10

* This location was not planted rice but was found coming up "naturally."

Water Column Analysis in Twin Lakes Rice Beds

25-Aug-16	Units	Reportable Detection Limit	Sandy Lake East	Sandy Lake NW	Sandy Lake SW	Sandy Lake South (Natural)*	Little Sandy South	Little Sandy NE
N, NH3	mg/L	0.10	**0.35**	**0.36**	**0.39**	**0.48**	<0.10	**0.13**
N, Kjeldahl	mg/L	0.60	**1.7**	**1.6**	**1.8**	**2.1**	**1.3**	**1.3**
Aluminum	mg/L	50.0	**64.0**	**58.7**	**99.5**	**196**	<50.0	<50.0
Calcium	mg/L	0.50	**30.8**	**33.4**	**27.6**	**22.5**	**44.5**	**39.7**
Iron	ug/L	50.0	**2850**	**2760**	**4720**	**10800**	**1580**	**1630**
Magnesium	mg/L	0.50	**39.6**	**43.7**	**35.7**	**27.3**	**62.8**	**55.4**
Manganese	ug/L	10.0	**88.9**	**126**	**178**	**243**	**97.8**	**132**
Potassium	mg/L	0.50	**2.5**	**2.7**	**2.4**	**2.1**	**3.1**	**2.7**
Sodium	mg/L	0.50	**13.5**	**14.6**	**12.7**	**11.4**	**21.1**	**17.4**
Total Hardness	mg/L	3.3	**240**	**263**	**216**	**168**	**370**	**327**
Alkalinity, (Tot)	mg/L	6.1	**168**	**178**	**156**	**118**	**229**	**223**
Total Dis. Solids	mg/L	10.0	**380**	**393**	**389**	**339**	**472**	**535**
Total Susp. Solids	mg/L	1.0	**2.8**	**2.0**	**2.0**	**16.7**	**2.0**	**3.6**
Chloride	mg/L	1.0	**17.2**	**18.0**	**17.2**	**17.5**	**27.9**	**21.9**
Sulfate	mg/L	2.0	**77.0**	**87.2**	**70.2**	**43.5**	**152**	**121**
Dis. Org. Carbon	mg/L	1.0	**42.0**	**40.7**	**47.2**	**51.2**	**33.9**	**36.1**
pH	Units	± 0.2	**7.6**	**7.7**	**7.3**	**6.5**	**7.7**	**7.8**
Sp. Conductance	mv	± 1%	**469**	**498**	**439**	**277**	**725**	**648**
Temperature	° C	± 0.1	**20.6**	**21.0**	**20.6**	**18.1**	**20.4**	**21.2**

* This location was not planted rice but was found coming up "naturally."

28-Sep-16	Units	Reportable Detection Limit	Sandy Lake East	Sandy Lake NW	Sandy Lake SW	Sandy Lake South (Natural)*	Little Sandy South	Little Sandy NE
N, NH3	mg/L	0.10	**0.12**	**0.11**	**0.11**	**0.10**	<0.10	<0.10
N, Kjeldahl	mg/L	0.60	**1.2**	**1.0**	**1.0**	**0.87**	**0.81**	**0.80**
Aluminum	mg/L	50.0	**53.3**	**59.9**	**56.5**	NM	<50.0	<50.0
Calcium	mg/L	0.50	**34.3**	**38.0**	**35.3**	NM	**48.0**	**45.9**
Iron	ug/L	50.0	**1240**	**1110**	**1350**	NM	**565**	**569**
Magnesium	mg/L	0.50	**45.9**	**51.6**	**48.1**	NM	**65.9**	**63.8**
Manganese	ug/L	10.0	**42.3**	**56.8**	**55.9**	NM	**74.6**	**93.0**
Potassium	mg/L	0.50	**2.9**	**3.2**	**3.0**	NM	**4.2**	**3.7**
Sodium	mg/L	0.50	**16.4**	**18.2**	**17.1**	NM	**23.4**	**21.7**
Total Hardness	mg/L	3.3	**275**	**307**	**286**	NM	**391**	**377**
Alkalinity, (Tot)	mg/L	6.1	**188**	**189**	**172**	**52.7**	**221**	**221**
Total Dis. Solids	mg/L	10.0	**393**	**461**	**403**	**198**	**541**	**516**
Total Susp. Solids	mg/L	1.0	**2.0**	**3.6**	**3.6**	NM	**1.6**	<1.0
Chloride	mg/L	1.0	**24.8**	**26.9**	**25.5**	**29.6**	**35.6**	**32.0**
Sulfate	mg/L	2.0	**100**	**123**	**108**	**12.9**	**176**	**159**
Dis. Org. Carbon	mg/L	1.0	**31.5**	**30.0**	**31.2**	NM	**24.8**	**25.7**
pH	Units	± 0.2	**8.0**	**8.0**	**7.9**	**7.1**	**8.0**	**8.1**
Sp. Conductance	mv	± 1%	**559**	**619**	**572**	**295**	**786**	**741**
Temperature	° C	± 0.1	**11.2**	**11.7**	**11.2**	**11.1**	**11.6**	**12.1**

* This location was not planted rice but was found coming up "naturally."

Water Column Analysis in Twin Lakes Rice Beds

			25-Aug-16										
	Units	Reportable Detection Limit	Rice Bed Sandy Lake East	Water Col Sandy Lake Outflow	Rice Bed Sandy Lake NW	Rice Bed Sandy Lake SW	Rice Bed Sandy Lake South (Natural)*	Sandy Lake Inflow South	Rice Bed Little Sandy South	Water Col Little Sandy Inflow 1	Rice Bed Little Sandy NE	Water Col Little Sandy Inflow 2	Water Col Little Sandy Inflow 3
N, NH3	mg/L	0.10	0.35	0.32	0.36	0.39	0.48	0.63	<0.10	<0.10	0.13	0.29	0.16
N, Kjeldahl	mg/L	0.60	1.7	1.5	1.6	1.8	2.1	2.1	1.3	0.87	1.3	2.1	1.3
Aluminum	mg/L	50.0	64.0	57.3	58.7	99.5	196	213	<50.0	70.5	<50.0	111	<50.0
Calcium	mg/L	0.50	30.8	28.0	33.4	27.6	22.5	12.9	44.5	69.6	39.7	38.6	40.0
Iron	ug/L	50.0	2850	3280	2760	4720	10800	14900	1580	2060	1630	2250	1650
Magnesium	mg/L	0.50	39.6	33.4	43.7	35.7	27.3	12.1	62.8	99.3	55.4	53.5	56.0
Manganese	ug/L	10.0	88.9	136	126	178	243	267	97.8	138	132	214	220
Potassium	mg/L	0.50	2.5	2.2	2.7	2.4	2.1	1.5	3.1	5.5	2.7	2.3	2.5
Sodium	mg/L	0.50	13.5	11.7	14.6	12.7	11.4	8.5	21.1	39.0	17.4	15.4	16.8
Total Hardness	mg/L	3.3	240	207	263	216	168	82.2	370	582	327	317	330
Alkalinity, (Tot)	mg/L	6.1	168	152	178	156	118	59.7	229	278	223	240	237
Total Dis. Solids	mg/L	10.0	380	356	393	389	339	251	472	836	535	434	473
Total Susp. Solids	mg/L	1.0	2.8	<1.0	2.0	2.0	16.7	8.0	2.0	2.8	3.6	22.0	5.2
Chloride	mg/L	1.0	17.2	15.4	18.0	17.2	17.5	18.7	27.9	56.5	21.9	18.6	20.2
Sulfate	mg/L	2.0	77.0	64.3	87.2	70.2	43.5	<2.0	152	314	121	96.7	108
Dis. Org. Carbon	mg/L	1.0	42.0	39.1	40.7	47.2	51.2	55.3	33.9	22.1	36.1	38.9	37.1
pH	Units	± 0.2	7.6	7.3	7.7	7.3	6.5	6.4	7.7	7.1	7.8	7.4	7.2
Sp. Conductance	mv	± 1%	469	417	498	439	277	209	725	1141	648	600	600
Temperature	° C	± 0.1	20.6	20.0	21.0	20.6	18.1	17.2	20.4	19.1	21.2	20.2	19.8

* This location was not planted rice but was found coming up "naturally."

Water Column Analysis in Twin Lakes Rice Beds

			28-Sep-16										
	Units	Reportable Detection Limit	Rice Bed Sandy Lake East	Water Col Sandy Lake Outflow	Rice Bed Sandy Lake NW	Rice Bed Sandy Lake SW	Rice Bed Sandy Lake South (Natural)*	Sandy Lake Inflow South	Rice Bed Little Sandy South	Water Col Little Sandy Inflow 1	Rice Bed Little Sandy NE	Water Col Little Sandy Inflow 2	Water Col Little Sandy Inflow 3
N, NH3	mg/L	0.10	0.12	0.11	0.11	0.11	0.10	0.11	<0.10	<10.0	<0.10	<0.10	<10.0
N, Kjeldahl	mg/L	0.60	1.2	0.94	1.0	1.0	0.87	0.79	0.81	0.71	0.80	0.88	0.85
Aluminum	mg/L	50.0	53.3	<50.0	59.9	56.5	NM	65.4	<50.0	84.6	<50.0	<50.0	<50.0
Calcium	mg/L	0.50	34.3	28.6	38.0	35.3	NM	7.2	48.0	54.4	45.9	47.4	30.9
Iron	ug/L	50.0	1240	1420	1110	1350	NM	3290	565	1150	569	455	353
Magnesium	mg/L	0.50	45.9	36.0	51.6	48.1	NM	7.8	65.9	72.6	63.8	65.9	49.4
Manganese	ug/L	10.0	42.3	54.1	56.8	55.9	NM	119	74.6	84.7	93.0	84.0	90.6
Potassium	mg/L	0.50	2.9	2.6	3.2	3.0	NM	2.8	4.2	5.8	3.7	3.3	1.5
Sodium	mg/L	0.50	16.4	13.3	18.2	17.1	NM	11.5	23.4	28.4	21.7	20.9	9.2
Total Hardness	mg/L	3.3	275	220	307	286	NM	50.2	391	435	377	390	280
Alkalinity, (Tot)	mg/L	6.1	188	145	189	172	52.7	34.7	221	207	221	251	255
Total Dis. Solids	mg/L	10.0	393	346	461	403	198	158	541	661	516	561	367
Total Susp. Solids	mg/L	1.0	2.0	2.4	3.6	3.6	NM	3.2	1.6	3.2	<1.0	3.6	2.4
Chloride	mg/L	1.0	24.8	21.1	26.9	25.5	29.6	30.0	35.6	47.0	32.0	31.5	12.5
Sulfate	mg/L	2.0	100	81.9	123	108	12.9	<2.0	176	229	159	165	39.6
Dis. Org. Carbon	mg/L	1.0	31.5	27.9	30.0	31.2	NM	22.6	24.8	19.5	25.7	27.7	32.2
pH	Units	± 0.2	8.0	7.6	8.0	7.9	7.1	6.5	8.0	7.3	8.1	7.8	7.4
Sp. Conductance	mv	± 1%	559	462	619	572	295	172	786	895	741	781	517
Temperature	° C	± 0.1	11.2	11.0	11.7	11.2	11.1	11.1	11.6	10.9	12.1	11.7	11.8

* This location was not planted rice but was found coming up "naturally."

Peeper Pore water Analysis in Twin Lakes Rice Beds
Compared to Seasonal Locations

	Units	Reportable Detection Limit	Rice Bed Sandy Lake East	2016 Twin Lakes Outflow	Rice Bed Sandy Lake NW	2016 Sandy Lake Middle	Rice Bed Sandy Lake SW	Rice Bed SL South (Natural)*	2016 LSL Outlet	Rice Bed Little Sandy South	2016 LSL Inflow 1
Sulfide	mg/L	0.10	<0.10	0.11-0.34	<0.10	0.13-0.25	<0.10	**0.15**	0.28-3.5	<0.10	0.37-1.5
Iron	mg/L	50.0	**0.5**	2.1-15.6	**1.2**	0.7-8.6	**1.2**	**37.7**	0.9-12.7	**15.4**	0.9-4.8
Sulfate	mg/L	10.0	**370**	<2.0-39.7	**358**	<2.0-105	**107**	**284**	<2.0-18.2	**423**	<2.0-81.3

*	This location was not planted rice but was found coming up "naturally."
Red	Data in Red are pore water monthly results taken from April through September.
Black	Data in Black are pore water results taken from August 25 - September 28 in Rice Beds.

Appendix H

Twin Lakes 2017 Activities Plan

U. S. Steel Minntac

Twin Lakes Wild Rice Restoration Opportunities Plan

Proposed Implementation Plan - 2017 Plan Activities

April-17	May-17	June-17	July-17	August-17	September-17	October-17	November-17	December-17
1 Install PT at Bridge	1 Monthly Water Quantity / Quality Monitoring	1 Monthly Water Quantity / Quality Monitoring	1 Monthly Water Quantity / Quality Monitoring	1 Monthly Water Quantity / Quality Monitoring	1 Monthly Water Quantity / Quality Monitoring	1 Monthly Water Quantity / Quality Monitoring	1 Collect water depth data and remove PT for Winter storage	1 Prepare and Submit Annual Report 12/31/17
2 Deploy Peepers	2 Collect water depth data	2 Collect water depth data	2 Collect water depth data	2 Collect water depth data	2 Collect water depth data	2 Collect water depth data		
	3 Observe and document WR growth	3 Observe and document WR growth	3 Observe and document WR growth	3 Observe and document WR growth	3 Observe and document WR growth	3 Recover Peepers		
	4 Recover Peepers and redeploy	4 Recover Peepers and redeploy	4 Recover Peepers and redeploy	4 Recover Peepers and redeploy	4 Recover Peepers and redeploy			
	5 Assess beaver and dam removal situation. Remove as needed	5 Assess pore water sulfide from Inflow 2 peeper. Complete pilot-scale ZVI application	5 Reassess beaver and dam removal situation. Remove as needed	5 Complete Aquatic Plant Survey				
			6 Consider 2017 seeding efforts and source of wild rice seed					

Environmental Science & Engineering

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Twin Lakes Wild Rice Restoration

Opportunities Plan

2016 Annual Report

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